In The

Supreme Court of the United States

October Term, 1979

No. 79-414

BASIC INCORPORATED
Petitioner,

vs.

ELTRA CORPORATION
Respondent

PETITION FOR WRIT OF CERTIORARI

To the United States Court of Appeals for the Sixth Circuit

GEORGE B. NEWITT
Allegretti, Newitt, Witcoff
& McAndrews
125 South Wacker Drive
Chicago, Illinois 60606
(312) 372-2160

ARMAND P. BOISSELLE
Maky, Renner, Otto
& Boisselle
601 Rockwell Avenue
Cleveland, Ohio 44114
(216) 621-1113

Attorneys for Petitioner

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BASIC INCORPORATED
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To the United States Court of Appeals for the Sixth Circuit

Petitioner Basic Incorporated respectfully prays that the Court issue its Writ of Certiorari to the United States Court of Appeals for the Sixth Circuit to review the judgment in Cause No. 77-3364 on the docket of that Court.

OPINIONS BELOW

The opinion of the Court of Appeals for the Sixth Circuit is not reported at this time but is reproduced in Appendix A.

The order of the United States Court of Appeals for the Sixth Circuit issued in response to petitioner's Petition for Rehearing also is not reported at this time but is reproduced as Appendix B.

The memorandum opinion of the District Court is reported at F.Supp. , 193 U.S.P.Q. 426 and is reproduced in Appendix C.

The judgment entry and order of the District Court is not reported but is reproduced as Appendix D.

JURISDICTION

The judgment at the United States Court of Appeals for the Sixth Circuit is dated and was entered on May 21, 1979. Rehearing was denied on June 18, 1979. The jurisdiction of this court to review the decision of the United States Court of Appeals for the Sixth Circuit is invoked under 28 U.S.C. § 1254(1).

QUESTIONS PRESENTED

Presented to this Court for review is the decision in this case from the Sixth Circuit Court of Appeals which is in conflict with previous decisions of this Court and previous decisions of a majority of the circuits on the same issue.

(1) In a patent case, where an infringer assails the validity of the patent as claiming obvious subject matter under 35 U.S.C. § 103, what is the standard or quantum of proof required to overturn the presumption of validity afforded a patent by 35 U.S.C. § 282?

In accordance with this Court's Rule 53, one other question, particular to this case, is presented for review:

(2) Whether a court of appeals, in its efforts to follow this Court's mandate in *Graham v. John Deere Co.*, 383 U.S. 1 (1966) may substitute itself into the record as the "one skilled in the art" and base its decision on its own interpretation of technical evidence, contrary to the uncontradicted interpretation and conclusion in evidence of one skilled in the art. This question has not been decided by this Court.

CONSTITUTIONAL PROVISIONS AND STATUTES INVOLVED

The Constitutional provision with regard to patents is set forth in Article I, Section 8:

> The Congress shall have power . . . To promote the progress of science and useful arts by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries.

The United States patent statute is 35 U.S.C., and Sections 103 and 282 thereof read as follows:

§ 103. Conditions for patentability; non-obvious subject matter.

> A patent may not be obtained though the invention is not identically disclosed or described as set forth in Section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made. July 19, 1952, c. 950, § 1, 66 Stat. 798.

§ 282.

> A patent shall be presumed valid. Each claim of a patent (whether in independent, dependent, or multiple dependent form) shall be presumed valid independently of the validly of other claims; dependent or multiple dependent claims shall be presumed valid even though dependent upon an invalid claim. The burden of establishing invalidity of a patent or any claim thereof shall rest on the party asserting it . . . . July 19, 1952, c. 950 § 1, 66 Stat. 812, amended July 24, 1965, Pub.L. 89-83 § 10, 79 Stat. 261; Nov. 14, 1975, Pub.L. 94-131, § 10, 89 Stat. 692.

STATEMENT OF THE CASE

Petitioner is the owner of Reissue Patent Re. 27,111 (hereinafter the "Wilson patent") for an improvement in pitch-bonded refractory bricks commonly employed to line steel-making furnaces. The improvement is the use of thermal carbon black or certain mixtures of thermal black and other carbon blacks in the bricks which results in unique properties. The entire industry has adopted the invention and, except for respondent, is licensed under the Wilson patent.

Respondent instituted this declaratory judgment action seeking a declaration of invalidity and non-infringement of the Wilson patent. Respondent contended that the patent was invalid because it was obvious in view of the prior art. Petitioner counterclaimed for patent infringement.

Following a three and one-half day trial, District Judge Young held the patent valid and infringed, noting in his Memorandum Opinion that "the evidence is voluminous and conflicting in many details," but the "parties have examined and analyzed it in a great length in their printed post trial briefs, which total one hundred fifty-three pages in length." Noting that it was not necessary in this opinion to make another extended analysis of the evidence the district court stated:

> The basic rule is that a patent is presumed to be valid, and those who attack its validity, in order to succeed, must establish their case by clear and convincing evidence . . . .
>
> The plaintiff fails to establish any one of these propositions (invalidity contentions) at all, much less by clear convincing evidence.

The district court found that respondent had failed to establish obviousness of the Wilson patent claims. Specifically, the district court stated with respect to validity of the patent:

> [Wilson's] experimentation was discouraged by his fellow employees as being futile and unlikely to lead to any useful result . . . .
>
> [Wilson] found that thermal blacks of certain physical characteristics had marked effect in improving the performance of pitch-bonded refractories . . . .
>
> Wilson's invention was something entirely new and different from prior art . . . .
>
> Both before and since the invention, numbers of experts, including (respondent's), have tried to get the patent's results by other means, with no success whatsoever . . . .
>
> [T]he bricks made by the use of Wilson's invention immediately established themselves as far superior to anything also on the market.

On review, the court of appeals reversed the district court and held the patent invalid. At least in part, the reversal stemmed from the court of appeals' rejection of the standard of proof applied by the trial court (Appendix A, page 10):

> [T]he party claiming obviousness need only do so by a preponderance of the evidence. [citing *Dickstein v. Seventy Corp.*, 522 F.2d 1294 (6th Cir. 1975), *cert. denied* 423 U.S. 1055 (1976)]

Treating the issue of patent validity as a question of law and reviewing the record *de novo*, the court of appeals concluded that the Wilson invention was obvious.* The crux of the appellate court's holding was its statement

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*The prior art relied upon by the appellate court is the same as that relied upon by the examiner and the trial court. If the art considered to be relevant by the appellate and trial courts *had* been different from the art relied upon by the Patent Office examiner, the presumption of validity would have been weakened.

that "the proof fell far short of establishing the existence of" surprising and unexpected improvement in the strength and density of refractory bricks over those using graphite (Appendix A, page 14). In order to support this conclusion, the court of appeals reviewed and interpreted certain "technical evidence" and drew its own conclusions therefrom which were directly in conflict with the conclusions of the experts (specifically, respondent's expert Dr. Brezny) expressed in documentary evidence (Appendix A, pages 18-20). The court of appeals failed to appreciate that small differences in results, insignificant to a layman, represented a significant advance to one of ordinary skill in the refractories art. As a result, the court of appeals made its ultimate determination, not as one skilled in the art, but as an unscientifically trained layman.

REASON FOR GRANTING THE WRIT

1. The Court Should Grant a Writ Of Certiorari Because The Decision Of The Court of Appeals On The Quantum Of Evidence Required To Overcome The Statutory Presumption Of Validity Of Patents Under 35 U.S.C. § 282 Is In Conflict With Prior Decisions Of This Court And The Courts Of Appeals In The Majority Of The Circuits.

In 1934 this Court considered the quantum of evidence required to overcome the statutory presumption of validity afforded a United States patent under 35 U.S.C. § 282, and recognized that confusion existed in the various circuits. In an effort to settle the issue, Mr. Justice Cardozo wrote:

> A patent regularly issued, ... is presumed to be valid until the presumption has been overcome by convincing evidence of error . . . . The force of that presumption has found varying expression in this and other courts . . . [A]n infringer who assails the validity of a patent fair upon its face bears a heavy burden of

> persuasion, and fails unless his evidence has *more than a dubious preponderance. Radio Corporation of America v. Radio Engineering Laboratories, Inc.*, 293 U.S. 1, 7 (1934).

In *Mumm v. Decker & Sons*, 301 U.S. 168 (1937), Mr. Justice Hughes reiterated:

> Not only is the burden to make good this defense (want of novelty) upon the party setting it up, but his burden is a *heavy* one, ... *Id.* at 171.

Following the statutory mandate of this Court's decisions, the courts of appeals of a majority of the circuits have placed a heavy burden on the infringing party asserting invalidity of a patent and have required the infringing party to prove his case by clear and convincing evidence.

Rooted Hair, Inc. v. Ideal Toy Corp., 329 F.2d 761, 765 (2d Cir. 1964), ("Heavy burden of proof . . . . clear and convincing evidence.") *But see Rains v. Niaqua, Inc.*, 406 F.2d 275 (2d Cir. 1969); *Tokyo Shibaura Electric Co. v. Zenith Radio Corp.*, 548 F.2d 88, 93 (3d Cir. 1977), ("In this circuit invalidity must be demonstrated by clear and convincing proof."); *Gaddis v. Calgon Corp.*, 506 F.2d 880, 885 (5th Cir. 1975), ("The presumption of validity is a strong one and is not to be overthrown except by clear and cogent evidence."); *Mercantile National Bank of Chicago et al v. Quest, Inc.*, 431 F.2d 261, 264 (7th Cir. 1970), ("[T]he party alleging invalidity assumes the burden of establishing invalidity by clear and convincing evidence."); *Wisconsin Alumni Research Foundation v. George A. Breon & Co.*, 85 F.2d 166, 167 (8th Cir. 1936), ("bears a heavy burden of persuasion, and fails unless his evidence has more than a dubious preponderance."); *Hayes, Spray Gun Co. v. E. C. Brown Co.*, 291 F.2d 319, 322 (9th Cir. 1961), ("Such presumption [validity] can be overcome only by clear and convincing evidence."); *Sidewinder Marine, Inc. v. Starbuck Kustom Boats and Prods., Inc.*, 597 F.2d 201, 205 (10th Cir. 1979),

("the burden . . . is heavy . . . must introduce 'clear and convincing' evidence . . . and 'every reasonable doubt should be resolved against him'."); *Haloro, Inc. v. Owens-Corning Fiber Glass Corp.*, 266 F.2d 918, 919 (D.C. Cir. 1959), ("[P]roof to sustain the burden is heavy. It must be 'by clear and convincing evidence'.").

The First Circuit affirmed "a preponderance of the credible evidence" in contrast to "the traditional teaching that the statutory presumption of validity can in the normal case be overcome only by a stronger factual showing than . . . a preponderance", *Futorian Mfg. Corp. v. Dual Mfg. & Eng. Corp.*, 528 F.2d 941, 943 (1st Cir. 1976). The Fourth Circuit appears to be in accord with the First. *Universal, Inc. v. Kay Mfg. Corp.*, 301 F.2d 140, 148 (4th Cir. 1962).

The district court in the case at bar followed this Court's instruction in *RCA* and *Mumm*, but the court of appeals for the Sixth Circuit, in direct conflict with these decisions, has adopted and continues to apply a lower standard of proof which requires only that the party asserting invalidity of a patent prove his case by a preponderance of the evidence. See *Reynolds Metals Co. v. Acorn Building Components, Inc.*, 548 F.2d 155 (6th Cir. 1977); *Dickstein v. Seventy Corp.*, 522 F.2d 1294 (6th Cir. 1975), *cert. denied* 423 U.S. 1055 (1976); and *Sperberg v. Goodyear Tire & Rubber Co.*, 519 F.2d 708 (6th Cir. 1975) *cert. denied* 423 U.S. 987 (1975).

In *Dickstein*, as in this case, the Sixth Circuit reversed a district court decision which required "clear and convincing evidence" and concluded, contrary to other circuits, "this strict standard is necessary when unusual factual circumstances . . . require it", 522 F.2d at 1296.

In *Campbell v. Spectrum Automation Co.*, 513 F.2d 932 (6th Cir. 1975), the court reviewed the cases and recognized that the application of the "clear and convincing" standard varies among the circuits, quoting Judge Clark who remarked that the authorities dealing with the

issue of the quantum of proof are "in a morass of conflict." *Stamicarbon, N.V. v. Escambia Chemical Corp.*, 430 F.2d 920, 924 (5th Cir. 1970).

The quantum of proof on the issue of obviousness required to overcome the statutory presumption of validity afforded by 35 U.S.C. § 282 is fundamental in the patent law. It is imperative that the standard be uniform throughout the United States. The law of the Sixth Circuit enunciated in the present case and in previous decisions is in conflict with the decisions of this Court and the majority of the circuit courts of appeals.

As American companies compete aggressively with foreign companies for the consumer's dollar, patent rights become increasingly important. It is time for this Court to express itself and bring uniformity into the law on this important issue.

2. The Court Should Grant A Writ Of Certiorari Because The Court Of Appeals Erroneously Rejected The Opinions And Conclusions Of Those Skilled In The Refractories Art Regarding The Unexpected And Improved Results Obtained With Thermal Black, Made Its Own Analysis Of The Technical Evidence And Substituted Its Own Conclusions For Those In Evidence. This Specific Issue Has Not Been Decided By This Court

After the trial, the district court concluded that the process described in the Wilson patent was "something entirely new and different from prior art" (Appendix C, page 7).

The court of appeals, however, concluded that the proofs did not establish the existence of such a difference (Appendix A, page 12). To reach this conclusion, the court of appeals had to dispose of technical reports by respondent's own expert, Dr. Brezny, in which Dr. Brezny reported the results of experiments he conducted to compare the effect of thermal carbon black (Wilson's inven-

tion) with other carbon additives previously disclosed. Dr. Brezny's unambiguous and uncontradicted conclusion was:

> All experiments to replace the presently used carbon black (thermal carbon black) resulted in degradation of quality.

Although Dr. Brezny's conclusion that thermal carbon black is superior to other carbon additives was accepted by respondent, a corporation employing many people skilled in this art, the court of appeals held that Brezny's conclusions were not supported by the test results contained in his reports (Appendix A, pages 18-20).

The court of appeals, by interjecting itself into the record as one skilled in the art and by making its own scientifically-uninformed evaluation of "technical evidence" to arrive at a conclusion wholly adverse to the uncontradicted conclusions of those skilled in the art, has failed to make the factual inquiry required by this Court in *Graham v. John Deere Co.*, 383 U.S. 1 (1966).

In *Graham*, this Court called for "strict observance" of the requirements of 35 U.S.C. § 103 and established a clear four step factual inquiry to be followed in determining obviousness:

> While the ultimate question of patent validity is one of law [citations omitted], the § 103 condition . . . lends itself to several basic factual inquiries. Under § 103, the scope and content of the prior art are to be determined; differences between the prior art and the claims at issue are to be ascertained; and the level of ordinary skill in the pertinent art resolved. Against this background, the obviousness or non-obviousness of the subject matter is determined. *Id.* at page 17.

Mr. Justice Marshall, speaking for this Court in *Dann v. Johnston*, 425 U.S. 219 (1976), wrote at page 229:

> In making the determination of 'obviousness', it is important to remember that the criterion is measured not in terms of what would be obvious to a layman but rather what would be obvious to one reasonably skilled in [the applicable] art.

In patent cases involving complex technologies, such as the case at bar, these basic factual inquiries often require analysis of technical evidence. *Graham* and *Dann* dictate that the courts determine what such "technical evidence" means to one of reasonable skill in the art, not what such "technical evidence" means to a layman.

The courts generally have acknowledged the importance of expert testimony in making the determinations concerning obviousness. In *Malsbary Mfg. Co. v. Ald, Inc.*, 447 F.2d 809, 811 (7th Cir. 1971), the court observed:

> Since the 'level of ordinary skill' in a particular art has not usually been defined in writing, the usual way of determining such level is by referring to the subjective reaction of a person thoroughly familiar with the particular art and, if possible, one who practiced the art at the crucial time in question.

In contrast, the court below, disregarding the mandates of this Court, has substituted itself for one skilled in the art, displacing competent expert testimony, the proper evidence for determining obviousness.

CONCLUSION

Petitioner recognizes that the crowded docket of this Court does not permit review of every case where error has been committed. However, where, as here, the case involves conflicts between circuits, and conflicts involving issues of federal law not previously decided by this Court, the writ should be granted. This case presents substantial questions of importance to this country's patent system that merit attention.

Respectfully Submitted

GEORGE B. NEWITT
Allegretti, Newitt, Witcoff
& McAndrews
125 South Wacker Drive
Chicago, Illinois 60606
(312) 372-2160

ARMAND P. BOISSELLE
Maky, Renner, Otto
& Boisselle
601 Rockwell Avenue
Cleveland, Ohio 44114
(216) 621-1113

Attorneys for Petitioner

Sept. 10, 1979

Appendix A

No. 77-3364

UNITED STATES COURT OF APPEALS

FOR THE SIXTH CIRCUIT

ELTRA CORPORATION,
Plaintiff-Appellant,

v.

BASIC INCORPORATED,
Defendant-Appellee

} APPEAL from United States District Court for the Northern District of Ohio, Western Division.

Decided and Filed May 21, 1979.

Before WEICK, ENGEL and MERRITT, Circuit Judges.

WEICK, Circuit Judge. The suit in the District Court was brought by Eltra Corporation (Eltra) against Basic Incorporated (Basic) seeking a declaratory judgment that Basic's Reissue Patent No. Re. 27-111, entitled "Pitch-Bonded Refractory Composition" was invalid and noninfringed. Basic responded by counterclaiming against Eltra for infringement of its patent by North American Refractories Company (Narco), a division of Eltra. The subject matter of the patent in suit is a process for making pitch-bonded refractory bricks used to line furnaces in which steel is made by the basic oxygen process.

Following a bench trial the District Court held that the patent in suit was valid and infringed. The Court further held that Basic was entitled to treble damages under 35 U.S.C. § 284 because the infringement was "deliberate and intentional." The Court also held that Basic was entitled to attorney's fees under 35 U.S.C. § 285 because Eltra's claim of fraud on the patent office was a "smoke

screen." A later hearing on the amount of damages and fees to be awarded was to be held if the parties could not agree on the amounts.

We disagree and reverse. In our opinion the patent in suit is invalid for obviousness under 35 U.S.C. § 103. Accordingly, Basic is not entitled to either damages or attorney's fees, and it is not necessary for us to reach either the claim of fraud on the patent office or the issue of infringement. Additionally, even if the patent were valid, we can perceive no basis in the record of this case for awarding Basic either treble damages or attorney's fees.

I

The parties in this case are competitors in the manufacture and sale of pitch-bonded refractory bricks. These bricks are used in the steel industry to line the inside of basic oxygen furnaces. The basic oxygen process for steelmaking became generally used and accepted in this country during the 1950's. While refractory materials had always been used in steelmaking, producers found in the 1950's and 1960's that they needed an improved brick, one which would last longer under the adverse conditions present in the basic oxygen furnace.

The essential process for making pitch-bonded refractory bricks is well known. A refractory material such as magnesia or dolomite is combined with a hydrocarbon binder (pitch). The mixture is compressed, formed into a brick, and baked. Basic's claimed invention involves the addition of small amounts of carbon of specified varieties to the mixture[1]. According to the patent's specifications, bricks made by this process will exhibit improved qualities as to oxidation, crushing strength and density.

[1] The original patent included broad claims to the use of many forms of carbon including carbon black and graphite. (See note 6, *infra*, for an explanation of these terms.) The patent's specifications, however, expressed a preference for carbon black.

The invention of this formula was allegedly made in 1960 by a then employee of Basic, Roger E. Wilson. U. S. Letters Patent No. 3,236,664 were originally issued to him on his application filed in 1962. Thereafter, officers at Basic realized that the original patent might not be valid in light of an earlier, similar Canadian patent No. 614,742 issued to one Lisle Hodnett.[2] This patent had not been before the patent examiner. An application for a reissue patent[3] was filed in 1969. This application narrowed the original claims, deleted some, and apparently attempted to distinguish them from Hodnett, although the Hodnett patent was again not cited to the patent office. In spite of this omission, the examiner located the prior art patent on

[2] The evidence showed that Basic had acquired a license under the Hodnett patent in 1961 for the nominal price of $1 per year. Basic's officials did not rediscover the existence of the Hodnett patent until sometime later, possibly as late as 1968.

[3] Under 35 U.S.C. § 251 a patent may be reissued under the following circumstances:

> **§ 251. Reissue of defective patents**
>
> Whenever any patent is, through error without any deceptive intention, deemed wholly or partly inoperative or invalid, by reason of a defective specification or drawing, or by reason of the patentee claiming more or less than he had a right to claim in the patent, the Commissioner shall, on the surrender of such patent and the payment of the fee required by law, reissue the patent for the invention disclosed in the original patent, and in accordance with a new and amended application, for the unexpired part of the term of the original patent. No new matter shall be introduced into the application for reissue.
>
> . . . .

In *Bolkcom v. Carborundum Co.*, 523 F.2d 492 (6th Cir. 1975), *cert. denied*, 425 U.S. 951 (1976), we emphasized that "this section is intended only to permit the reissue of a patent for the *same invention* as that disclosed in the original patent in order to correct an inadvertant defect or omission." *Id.* at 502 (emphasis in original).

his own and cited it in rejecting the reissue application. After amendment, the reissue patent was eventually granted in 1970 with the specific claims stated in the margin.[4]

The process described in the original and reissue patents has enjoyed some commercial success. In 1968 the Narco division of Eltra began producing bricks under a licensing agreement with Basic. The largest company in the business, Harbison Walker, also acquired a license to use the process, as did a smaller firm. More recently, several other refractory producers have followed suit.

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[4] The claims in the reissue patent provide as follows (material in roman was retained from the original patent; material in brackets was omitted upon reissue; material in italics was added upon reissue):

1. [omitted entirely]

2. In the method of forming a shaped, [green] *grain* refractory article by admixing dead-burned basic refractory particles with sufficient pitch capable of pyrolytic decomposition to bind said particles together and then shaping the admixtures by pressure; the improvement which consists of adding approximately 0.5 to 10 percent by weight, based on the weight of the total admixture, of finely divided carbon black to the admixture prior to such shaping [.] *to produce such a shape of increased density and crushing strength, such carbon black having an average particle size of about 20 to about 500 millimicrons and a surface area of from about 5 to about 375 square meters per gram, at least one third of the carbon black being thermal black having an average particle diameter of about 180-470 millimicrons and a surface area of about 6-13 square meters per gram.*

3. [omitted entirely]

4. In the method of bonding dead-burned basic refractory particles one to another by admixing such particles with about 4 percent to about 10 percent by weight of the admixture coal tar pitch and then heating to coke the admixture and form a bonded mass; the improvement which consists of incorporating approximately 0.5 to 10 percent by weight, based on the weight of the total admixture, of powdered carbon black in the admixture prior to heating to improve the useful life of the bonded mass at elevated temperatures[.], *such carbon blacks having an average particle size of about 20 to about 500 millimicrons and a surface area of from about 5 to about 375 square meters per gram, at least one third of the carbon black being thermal black having an average particle diameter of about 180-470 millimicrons and a surface of about 6-13 square meters per gram.*

5. In the method of bonding refractory particles selected from the group consisting of dead-burned dolomite, dead-burned magnesia, and mixtures thereof by blending such particles with sufficient coal tar pitch to bind such particles together, shaping such blend, and then heating the resulting shape to a temperature sufficient to decompose pyrolytically the pitch and form a carbon bond; the improvement which consists of adding to the blend prior to the heating from about 0.5 percent to about 10 percent by weight thereof finely divided carbon black[.] *to increase the density and crushing strength of such shape, such carbon black having an average particle size of from about 20 to about 500 millimicrons and a surface area of about 5 to about 375 square meters per gram, at least one third of the carbon black being thermal*

In 1973, Narco became aware that Harbison-Walker had filed suit challenging the validity of the Wilson patent. Narco then consulted outside counsel and obtained an opinion that the Wilson patent was invalid. Narco thereafter ceased paying royalties to Basic, explaining that the patent was viewed as invalid. Basic and Narco attempted to renegotiate a mutually satisfactory licensing agreement. But when no agreement could be reached, the present suit was filed.

In the interim, Basic and Harbison-Walker settled their lawsuit. Their agreement provided Harbison-Walker with a royalty-free license under Basic's Wilson patent. In exchange for this Basic received a royalty-free license under a Harbison-Walker patent that was later held invalid in *Dresser Indus., Inc. v. Eltra Corp.*, 432 F.Supp. 153 (N.D. Ohio 1977) (Dresser Indus. is the successor to Harbison-Walker.

II

Eltra's principal contention is that the Wilson patent, as reissued, is invalid for obviousness under U.S.C. § 103. The section provides:

> § 103. Conditions for patentability; non-obvious subject matter
>
> A patent may not be obtained though the invention is not identically disclosed or described as set

black having an average particle diameter of about 180-470 millimicrons and a surface area of about 6-13 square meters per gram.

6. The method of claim 5 wherein such carbon black is selected from the group consisting of lamp blacks, channel blacks, furnace combustion blacks, thermal blacks and acetylene blacks.

7. The method of claim 5 wherein such carbon black has [properties within the following ranges:

Average particle diameter ..200 to 500 millimicrons.
Surface area .....5 to 375 square meters per gram.
Volatile content .....Less than 14% by weight.
Fixed carbon .....85 to 99.5% by weight.]

a volatile content of less than 14 percent by weight and a fixed carbon content of 88 to 99.5 percent by weight.

8. *In the method of bonding refractory particles selected from the group consisting of dead-burned dolomite, dead-burned magnesia and mixtures thereof by blending such particles with sufficient coal tar pitch to bind such particles together, shaping such blend, and then heating the resulting shape to a temperature sufficient to decompose pyrolytically the pitch and form a carbon bond; the improvement which consists of adding to the blend prior to the heating from about 0.5 percent to about 10 percent by weight thereof finely divided carbon black* [The method of claim 5 wherein], such carbon black [consists] *consisting* essentially of a blend of high oil absorbing carbon black and a thermal carbon black.

9. *In the method of bonding refractory particles selected from the group consisting of dead-burned dolomite, dead-burned magnesia and mixtures thereof by blending such*

> forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

particles with sufficient coal tar pitch to bind such particles together, shaping such blend, and then heating the resulting shape to a temperature sufficient to decompose pyrolytically the pitch and form a carbon bond; the improvement which consists of adding to the blend prior to the heating from about 0.5 percent to about 10 percent by weight thereof finely divided carbon black [the method of claim 5 wherein], such carbon black [consists] *consisting* essentially of a blend of a high oil absorbing carbon black having an oil absorption of at least 85 pounds of oil per 100 pounds of black and a thermal carbon black, said carbon black being present within a weight ratio of 2:1 to 1:2, respectively.

10. *In the method of bonding refractory particles selected from the group consisting of dead-burned dolomite, dead-burned magnesia and mixtures thereof by blending such particles with sufficient coal tar pitch to bind such particles together, shaping such blend, and then heating the resulting shape to a temperature sufficient to decompose pyrolytically the pitch and form a carbon bond; the improvement which consists of adding to the blend prior to the heating from about 0.5 percent to about 10 percent by weight thereof finely divided carbon black* [The method of claim 5 herein], such carbon black [consists] *consisting* essentially of a blend of substantially equal parts by weight of a high oil absorbing carbon black selected from the group consisting of a conductive oil furnace carbon black and a long flow channel carbon black having an oil absorption of at least 85 pounds of oil per 100 pounds of black, and a fine thermal carbon black.

11. In the method of bonding refractory particles selected from the group consisting of dead-burned dolomite, dead-burned magnesia, and mixtures thereof by blending such particles with sufficient coal tar pitch to bind said particles together, shaping such blend under pressure, and then heat-

In analyzing the validity of any patent we must begin with the statutory presumption of validity that accompanies its issuance, 35 U.S.C. § 282. *American Seating Co. v. National Seating Co.*, 586 F.2d 611, 615 (6th Cir. 1978). The presumption has no independent evidentiary significance, however, as it merely serves to allocate to the

ing the resulting shape to a temperature sufficient to decompose pyrolytically the pitch and form a carbon bond, the improvement which consists of adding to the blend prior to shaping approximately 0.5 to 10 percent by weight, based on the weight of the total admixture, of powdered carbon black containing particles having a diameter within the range of from about 20 millimicrons to about 500 millimicrons[.] *to increase the density and crushing strength of such carbon bonded shape, at least one third of such carbon black being thermal carbon black having an average particle diameter within the range of about 180 to about 470 millimicrons.*

12. [omitted entirely]

13. [omitted entirely]

14. A refractory article of manufacture consisting essentially of basic refractory particles, carbon black and a pyrolytically decomposed carbonaceous material selected from the group consisting of pitch, coal tar and bituminous asphalts, approximately 0.5 to 10 percent by weight, based on the weight of the total admixture, of said carbon black being present prior to such pyrolytic decomposition[.], *said refractory article having increased density and crushing strength and said carbon black having an average particle size of from about 20 to 500 millimicrons and a surface area of about 375 square meters per gram, at least one third of such carbon black being thermal black having an average particle diameter of about 180-470 millimicrons and a surface area of about 6-13 square meters per gram.*

15. *The method of claim 11 in which such powdered carbon black consists essentially of a blend of a high oil absorbing carbon black and a thermal carbon black, said carbon black being present within the weight ratio of 2:1 to 1:2 respectively.*

16. *A pitch-bonded refractory having high strength and increased density comprising*

basic refractory particles,

party claiming invalidity the burden of proving it.[5] *Reynolds Metals Co.* v. *Acorn Bldg. Components, Inc.*, 548 F.2d 155, 160 (6th Cir. 1977); *Dickstein* v. *Seventy Corp.*, 522 F.2d 1294, 1296 (6th Cir. 1975), *cert. denied*, 423 U.S. 1055 (1976); *Sperberg* v. *Goodyear Tire & Rub-*

sufficient carbonaceous material selected from the group consisting of pitch, coal tar and bituminous asphalts, capable of pyrolytic decomposition, to bind said particles together, and

approximately 0.5 to 10% by weight, based on the weight of the total admixture, of finely divided carbon black of noncrystalline structure, said carbon black having an average particle size of from about 20 to 500 millimicrons and a surface area from about 5 to about 375 square meters per gram, at least on (sic one) *third of the carbon black being thermal carbon black having an average particle diameter of from about 180 to about 470 millimicrons and a surface area of about 6-13 square meters per gram.*

17. *The refractory of claim 16 in which said finely divided carbon black consists essentially of a blend of a high oil absorbing carbon black and said thermal carbon black.*

18. *The refractory of claim 17 wherein the ratio of high oil absorbing carbon black to thermal carbon black is in the range of about 2:1 to about 1:2 respectively.*

19. *The refractory of claim 17 wherein said oil absorbing carbon black has an oil absorption of at least about 85 pounds of oil per 100 pounds of carbon black.*

20. *The refractory of claim 19 including about 4 to about 10% of carbonaceous material.*

21. *The refractory of claim 16 wherein the carbon black addition is substantially all thermal black.*

22. *The method of claim 5 wherein such carbon black comprises about 66 percent by weight to about 33 percent by weight thermal black.*

[Patent No. Re 27,111, Defendant's Ex. B.]

[5] In addition we believe that the presumption was seriously weakened in this case because of Basic's conduct before the patent office, where one document was misrepresented and another was withheld. *See* note 18, *infra*.

ber Co., 519 F.2d 708, 713 (6th Cir.), *cert. denied*, 423 U.S. 987 (1975); *Rains* v. *Niaqua, Inc.*, 406 F.2d 275, 278 (2d Cir.), *cert. denied*, 395 U.S. 909 (1969). In the typical case such as this, where the bulk of the evidence of the prior art is contained in documents, the party claiming obviousness need only do so by a preponderance of the evidence. *Dickstein, supra*, 522 F.2d at 1295-97; *cf. Campbell* v. *Spectrum Automation Co.*, 513 F.2d 932 (5th [Sic, 6th] Cir. 1975). The District Court was thus in error in stating that:

> The basic rule is that a patent is presumed to be valid, and those who attack its validity, in order to succeed, must establish their case by clear and convincing evidence.
>
> [App. 471.]

While this higher standard of proof may apply to the unusual case, such as where the evidence may be of an inherently unreliable nature, *see Dickstein, supra*, 522 F.2d at 1296; *Campbell, supra*, or where fraud is alleged, *see Schnadig Corp. v. Gains Mfg. Co., Inc.*, 494 F.2d 383, 392 (6th Cir. 1974), it is simply not the "basic rule" to be applied in cases involving alleged obviousness under 35 U.S.C. § 103.

In the seminal case of *Graham* v. *John Deere Co.*, 383 U.S. 1 (1966), the Supreme Court outlined the proper inquiry under section 103 as follows:

> [T]he scope and content of the prior art are to be determined; differences between the prior art and the claims at issue are to be ascertained; and the level of ordinary skill in the pertinent art resolved. Against this background, the obviousness or nonobviousness of the subject matter is determined.
>
> [*Id.* at 17.]

The Court continued:

> Such secondary considerations as commercial success, long felt but unsolved needs, failure of others, etc., might be utilized to give light to the circumstances surrounding the origin of the subject matter sought

> to be patented. As indicia of obviousness or nonobviousness, these inquiries may have relevancy.
>
> [*Id.* at 17-18.]

Essentially, nonobviousness is the statutory equivalent of the requirement of "invention," derived from the Supreme Court's decision in *Hotchkiss* v. *Greenwood*, 52 U.S. (11 How.) 248 (1851). *Sakraida* v. *Ag Pro, Inc.*, 425 U.S. 273, 279 (1976); *Dann* v. *Johnston*, 425 U.S. 219, 225-26 (1976); *Reynolds Metals, supra*, 548 F.2d at 159; *Monroe Auto Equip. Co.* v. *Heckethorn & Supply Co.*, 332 F.2d 406, 410 (6th Cir.), *cert. denied*, 379 U.S. 888 (1964). This requirement explicates the constitutional mandate that inventions must "promote the useful arts," Art. I, § 8, cl. 8. before a limited monopoly may be granted. *Anderson's Black-Rock* v. *Pavement Co.*, 396 U.S. 57, 61 (1969); *see Graham, supra*. Thus not every improvement in the art is patentable. To be nonobvious, the advancement must be the product of "inventive genius." *A. & P. Tea Co.* v. *Supermarket Corp.*, 340 U.S. 147, 154 (1950) (Douglas, J., concurring); *Mantle Lamp Co.* v. *Aluminum Co.*, 301 U.S. 544, 546 (1937); *Concrete Appliance* v. *Gomery*, 269 U.S. 177, 185 (1925); *Reckendorfer* v. *Faber*, 92 U.S. 347, 354 (1875). The standard of invention is a "demanding" one. *Lear, Inc. v. Adkins*, 395 U.S. 653, 676 (1969). As stated in *Dann, supra*, the question is

> whether the difference between the prior art and the subject matter in question "is a difference sufficient to render the claimed subject matter unobvious to one skilled in the applicable art. . . ."
>
> [425 U.S. at 228, quoting *Application of Johnston*, 502 F.2d 765, 772 (C.C.P.A. 1974) (Markey, C.J., dissenting).]

Although the subsidiary questions outlined in *Graham, supra*, are essentially factual, the ultimate issue is one of law. *Sakraida, supra*, 425 U.S. at 280; *Graham, supra*, 383 U.S. at 17; *American Seating, supra*, 586 F.2d at 619;

Nickola v. *Peterson*, 580 F.2d 898, 910-12 (6th Cir. 1978), *cert. denied*, 47 U.S.L.W. 3620 (1979); *Reynolds Metals*, *supra*, 548 F.2d at 161; *Kolene Corp.* v. *Motor City Metal Treating, Inc.*, 440 F.2d 77, 81 (6th Cir.), *cert. denied*, 404 U.S. 886 (1971). In our opinion the advancement disclosed in the Wilson reissue patent does not meet this standard in view of the prior art.

A

As set out in footnote 4, *supra*, the claims of the Wilson reissue patent relate to the process of adding small amounts (from .5% to 10% by weight) of carbon black,[6] where at least one third of the carbon black is a variety known as thermal black,[7] to the refractory mixture. The preferred amount of carbon additive is 2% to 3% by weight. One specific variety of the invention calls for the use of a mixture of thermal black with any of several "high oil absorbing blacks" (a subclass of carbon blacks). Another calls for the use of all thermal black.

The District Court concluded that the process described in the Wilson reissue patent was "something entirely new and different from prior art." App. 475. As a conclusion that the process was nonobvious it is patently incorrect. At least by 1944 it was known that the chemical resistance of refractory materials to wear and corrosion by slag during the steelmaking process could be improved by increasing the carbon content of the refractory mixture.

[6] The term carbon black describes a family of so-called "free carbons," where carbon exists in its elemental form not combined with any other chemical. Graphite is also a free carbon. The two forms differ, however, because carbon blacks are noncrystalline whereas graphite is a crystalline form of the element.

[7] Different varieties of carbon black are made by heat treating various hydrocarbons (*e.g.*, natural gas). Names are assigned (*e.g.*, thermal black) according to the process which is used. They are also divided according to their physical properties, particularly particle diameter and surface area.

This was taught in Australian patent No. 118,590 where it explained the utility of adding 2½% by weight of free carbon[8] in the form of flake graphite[9] to the refractory mixture.

The Hodnett Canadian patent, No. 614,742, which was issued more than a year prior to Wilson's original application,[10] also taught the value of carbon generally in making improved refractory materials. But the patent was also rather specific in teaching a process for making a better refractory brick for use in the steel industry. Hodnett called for the addition of from 0% to 7% by weight of "finely divided free carbon." The patent specified both graphite and carbon black, although it expressed a preference for graphite.[11] Carbon black was said to be less desirable because of its tendency to lower density.[12]

Basic places great emphasis on this last teaching because the core of its argument is that the carbon mixture

[8] *See* note 6, *supra*.

[9] *See* id.

[10] As explained in footnote 3 above, a reissue patent under 35 U.S.C. § 281 is fundamentally only a correction of the original patent. *Balkcom, supra*, 523 F.2d at 501-02. Thus in our opinion one must view the obviousness of the reissue claims to the same invention as of the time of invention, namely, the time of the original filing, *cf. U.S. Expansion Bolt Co.* v. *Jordan Indus., Inc.*, 488 F.2d 566, 568 & n.3 (3d Cir. 1973) (one looks to the time of the application in determining obviousness under 35 U.S.C. § 103).

[11] This case is thus unlike *United States* v. *Adams*, 383 U.S. 39, 51-52 (1966), where the prior art specifically taught that the invention sought to be patented was impractical and that the use of certain chemicals specified in the patent would be detrimental to the process.

[12] The District Court interpreted the Hodnett patent as follows:

> While certain broad language in both the Hodnett and Wilson patents refer to a wide spectrum of forms of finely divided carbon, what the Hodnett patent really covers is the use of certain forms of graphite. [App. 474.]

prescribed by Wilson gave rise to such a surprising and unexpected improvement in the strength and density of refractory bricks over those using graphite as to be patentable over the prior art, particularly Hodnett.[13] We believe that the proof fell far short of establishing the existence of such a difference.

Much evidence was presented at trial concerning the way in which carbon acts to affect the strength and density of pitch-bonded refractory bricks. The refractory material (here magnesia or dolomite) exists in the form of particles of irregular shapes and sizes. Even when combined with a pitch binder, formed into a brick, and baked, pores re-

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This finding is at least curious. As it relates to obviousness under section 103, what is important is that Hodnett taught as a disclosure of the prior art, not what it may or may not have "covered." As just noted in the text, the Hodnett patent explained that both carbon black and graphite were useful in practicing the invention. That the patent expressed a preference for graphite does not negative the fact that it also taught that carbon black was useful. Indeed in 1968 Basic's patent counsel advised that Hodnett disclosed the use of carbon black generally.

In addition, as the finding may relate to the scope of the invention claimed by Hodnett, carbon black was plainly within the "coverage" of the patent because it was specified in the claims of the patent. Under American patent law, the scope of any invention is measured by its claims, *Dickstein, supra,* 522 F.2d at 1297, although these must be read in light of the patent's specifications. *United States* v. *Adams, supra,* 383 U.S. at 49; *Phillips Indus. Inc.* v. *State Stove & Mfg. Co.,* 522 F.2d 1137, 1140 (6th Cir. 1975).

[13]Basic's carbon expert testified to his "amazement and surprise" when he first learned of the level of improvement that could be derived from the addition of only 2%-3% carbon black. Based on his own work in carbon bodies (not refractories), he would have expected only a negligible improvement in strength and density. We think that this testimony was of no particular persuasive value since Hodnett had already disclosed the quantity of free carbon necessary to effectuate a better brick. Wilson's patent only charged the material added, it did not alter the prior teaching as to the quantity to be used.

main between the particles. When those pores are filled with smaller particles, here carbon, the resulting brick exhibits improved crushing strength and density over bricks made simply with refractory and pitch. Using filler particle that are too large, however, can result in a weaker brick since refractory particles will be forced apart. Hence it is better to err on the side of having filler particles which are too small rather than too large. This much is basic in the art. It was also taught in the Heuer patent, U.S. No. 1,851,181 (1932). It should be noted that the improved *chemical* resistance of the bricks is achieved by the choice of carbon particles in order to increase the carbon content of the brick, as is explained above. Finally there was also some evidence that free carbon has some independent effect on the pitch binder which may cause additional improvement in the strength of the bricks, but not in their density.[14]

In pressing its claim on reissue before the patent office, and in an effort to distinguish Hodnett after it had been

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[14] The District Court made the rather cryptic finding:

> There was evidence from which it can be concluded that some chemical reactions took place between the thermal black and the pitch which caused the latter to become very much harder and stiffer than normal. [App. 472-73.]

To the extent that this is intended to relate to the independent effect that the free carbon might have on the pitch binder, which in turn may affect the strength of the refractory bricks, it has some support in the record (particularly in the specifications of the Wilson patent, column 2, lines 34-39, and in the testimony of Stanislav Mrozoski, App. 265). To the extent that it attempts to explain the overall process, however, it is clearly erroneous. It is apparently based on the ambiguous comment of one witness who admitted that he had no empirical support for it. App. 370. This "theory" was directly rebutted by another expert witness and was overwhelmed by the other evidence of the process of "particle stuffing." The evidence included documents provided by Basic to their patent attorneys which explained the process in terms of particle stuffing. Defendant's Ex. FR at 2.

cited by the patent examiner, Basic made the following representation:

> [S]ubstantial evidence has been submitted, in the Collin Hyde affidavit, as to the unexpected and surprising results achieved by the present invention (the affidavit compares the presently claimed species with the preferred species of the Hodnett patent).

The statement contained in the parentheses was false. The tests reported by Collin Hyde in his affidavit did not involve "the preferred species" of Hodnett. Hyde compared bricks made with a thermal black mixture to those made with a coarse variety of graphite (Joseph Dixon flake graphite 1101). Hodnett, however, had specified fine (or finely divided) graphite. Hyde reported that the use of coarse graphite actually *decreased* the density and compressive strength of the bricks over those containing no carbon additive at all. In contrast, Hyde found that the use of thermal black produced an increase in the density and strength of bricks over those containing no carbon additive. By representing the coarse graphite as Hodnett's "preferred species" the Hyde affidavit appeared to show two things: (1) it tended to disprove Hodnett by indicating that his process resulted in an inferior brick; (2) it tended to show that Wilson's process was far superior to Hodnett's. In truth the experiments reported in the affidavit offered no such basis for comparison because they did not replicate the Hodnett invention.[15]

It must be noted that Basic had in fact tested fine graphite, Hodnett's "preferred species," prior to this time. In 1960 Wilson reported tests in which he compared fine graphite to Joseph Dixon flake graphite 1101, the coarse graphite used in the Hyde experiments which were reported to the patent examiner. The tests showed that the fine graphite improved the density and compressive strength of refractory bricks whereas the coarse variety resulted in

[15] *See* note 18, *infra*.

a poorer quality brick, even poorer than one containing no additive. Plaintiff's Ex. 42. This report was not given to the patent examiner, even though it predated Hyde's affidavit.

More significantly, very little evidence was presented which directly compared fine graphite with carbon black generally, or with thermal black in particular. The Hyde affidavit purportedly did so and was presented both to the patent examiner and to the District Court. But as noted above, it did not offer a fair comparison of Wilson and Hodnett. The Wilson patent, either originally or as reissued, also does not furnish any report of a comparison test. The data provided only compares various carbon blacks. The specifications instruct that "pulverant carbon of on-cubic crystalline structure may also be used in practicing the invention. For example . . . graphite may be used, but such carbons are not as efficacious as carbon blacks." The patent offers neither explanation or data to support this claimed distinction.[16] Apparently, Basic's only reported direct comparison between fine graphite and thermal black was contained in a report by Collin Hyde which was dated four months earlier than the affidavit submitted to the patent examiner. The report showed that the addition of either thermal black or fine graphite increased the density and compressive strength of pitch-bonded refractory bricks. Neither additive was found to

[16] The District Court made the following finding:

> The Wilson patent excludes the particular variety of graphite covered by the Hodnett patent, since Wilson's experiments demonstrated that the variety of graphite decreased the density of the pitch-bonded refractory bricks, an undesirable characteristic. [App. 474-75.]

This finding is clearly erroneous in two respects. First the Wilson patent no where "excludes the particular variety of graphite covered by the Hodnett patent," because it no where discusses particular varieties of graphite. The most it does is express a preference for carbon black over graphite generally. Second, Wilson's

be the clear superior of the other.[17] Again this report was not given to the patent examiner.[18]

To show that thermal black is the clear surprising superior of fine graphite, Basic relies on the reports of one of Narco's scientists. In 1973 he reported on experiments which were conducted in an effort to get "outside" the Wilson patent. He compared the pressed (or "green")

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experiments, which are described in the text above, clearly do *not* show that Hodnett's preferred variety of graphite *decreases* the density of refractory bricks. To the contrary, the report plainly shows that fine graphite, Hodnett's preference, markedly *increased* and improved the density and strength of the bricks over those with no carbon additive.

[17] The test results showed the following:

Addition	Graphite		Thermal	Black
Amount	1%	2%	1%	2%
Amount of Liquid Pitch Added, lbs.	225	230	230	230
Batch Temperature, °F	255	250	240	240
Chart Density (avg 4), lb/ft³	187	186	186	186
Tempered Properties (avg 2)				
Bulk Density, lb/ft³				
Whole Brick, w/m	185	184	184	183
Segment, w/m	183	181	180	180
Compressive Strength, psi	7340	7560	6580	6760
Coked Properties (avg 4)				
Bulk Density, w/m, lb/ft³	181	179	180	179
Compressive Strength, psi	8030	7190	6990	7600
Expansion, %	0.18	0.18	0.18	0.84
Weight Loss, %	2.5	2.5	2.5	2.5
Residual Carbon, % (avg 8)	4.38	5.12	4.34	4.87

[Plaintiff's Ex. 277.]

[18] Although Basic entered this litigation with the benefit of the statutory presumption of validity under 35 U.S.C. § 282 noted above, it is axiomatic that its limited force can be weakened or destroyed where it is shown that the most relevant prior art was not disclosed to the patent examiner. *American Seating, supra,* 586 F.2d at 615; *Reynolds Metals, supra,* 548 F.2d at 160; *Bolkcom,*

densities[19] of bricks made with thermal black with those made with a thermal black-graphite mixture and with a thermal black-furnace mixture. He did not evaluate the coked density[20] of the bricks. Neither did the tests report on compressive strength, either green or coked. The most that this report shows is that the thermal-black-graphite mixture produced a reduction in pressed density. Notably, a mixture containing more graphite and less thermal black achieved an even smaller reduction in pressed density from bricks with pure thermal black.[21] Also, the report accompanying the data indicated that the reductions in

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supra, 523 F.2d at 498; *Tee-Pak Inc.* v. *St. Regis Paper Co.,* 491 F.2d 1193, 1196 (6th Cir. 1974). Similarly in this case we believe that the presumption was seriously weakened when Basic failed to disclose to the patent examiner the results of tests which came closest to comparing Hodnett and Wilson; and when Basic plainly misrepresented the nature of the tests reported in the Hyde affidavit. Because the examiner did not have the best and most accurate information before him we cannot entertain the usual presumption of the correctness of his conclusion.

[19] The terms "pressed density" and "green density" refer to the density of a newly formed brick. Similarly, the pressed or green compressive strength of a brick related to the physical properties of a new brick. In contrast, the "coked" properties of a brick refer to its characteristics after it has been exposed to the steelmaking process. The expert testimony showed that coked properties are more meaningful because they relate to the conditions that the bricks actually experience in the basic oxygen furnace.

[20] *See* note 19, *supra.*

[21] The actual test results were as follows:

	WT-8124 Control	WT-8124 A	WT-8124 B
Gal. of pitch per 4,000 lb. 90-95°C M.P. pitch	12.6	12.3	12.0
	2.5%	1.25%	0.5%
Carbon Black	—	1.25%	2.0%
Graphite (5 micron)	193.45	191.64	191.76
Density, pcf			

[Defendant's Ex. AO.]

density were at least in part due to a reduction in pitch content.

In sum, the technical evidence disclosed the following relative to the prior art and the alleged advancement made by Wilson: As to the prior art, it was well known that the chemical resistance of bricks to wear and corrosion could be improved by increasing the carbon content of the refractory mixture; it was also known that the strength and density of refractory materials could be improved through the addition of smaller particles into the mixture; Hodnett specifically taught the use of carbon particles in pitch-bonded refractory bricks; while graphite was preferred by Hodnett, it was clear that both graphite and carbon black were useful for his invention.[22]

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[22] One other piece of prior art deserves mention. The Swallen patent, U.S. No. 2,527,595 (1950), disclosed a method for improving the strength of carbon electrodes used in electric furnaces. These electrodes are produced by combining carbon flour with a pitch binder and baking the mixture to form a carbon body. The patent disclosed that the electrode could be made more resistant to chemical attack, and also stronger, through the addition of thermal black. Again this process involved essentially void-filling. Thermal black was chosen because of its range of particle sizes. The precise process for making the electrodes differs from that used to make refractory bricks. The quantity of thermal black used also differs (up to 40% by weight can be used in the Swallen process). Despite these differences, the purpose of the additive is similar to that involved in the Wilson and Hodnett processes and the method of manufacture is analogous. Therefore we think that the Swallen patent, as prior art, would at least point one toward the use of thermal black. In fact, in his deposition, Wilson stated that he had read the Swallen patent and found it useful to his work in 1961. Plaintiff's Ex. 422 at 78-79. While Swallen alone would not render Wilson's disclosures obvious, we believe that it is plainly relevant as shedding light on the general state of the art at the time of the Wilson application. *See Graham, supra,* 383 U.S. at 17; Fed. R. Evid. 401. Thus we believe that the District Court erred in concluding as to the Swallen patent:

> [T]his is totally irrelevant, if for no other reason than that electrodes use little or no refractory material such as dead-burned magnesia or dolomite, and are made by processes almost entirely different from those used in making the refractory bricks involved here. [App. 475.]

As to the alleged advancement made by Wilson, Basic claims that a patentable improvement over the prior art was achieved through the use of various mixtures of carbon blacks, particularly thermal black. The Wilson patent's specifications, however, also note that graphite may be used to practice the invention. Wilson simply expresses a preference for carbon black without documenting its superiority.

Eltra came forward with evidence which tended to show that the claimed "surprising and unexpected" improvements over Hodnett's teachings were incorrect and that fine graphite was indeed the equivalent of thermal black. Basic responded with evidence in the form of incomplete test results which tended to show that as to only *one* property thermal black exhibited superiority over fine graphite. Thus in our view the technical evidence showed that Basic had developed a process which produced a brick that in most respects was the equivalent of a brick produced by the Hodnett process. All Basic had accomplished was the substitution of thermal black, together with other carbon blacks, for graphite. It did not even change the relative proportions.[23]

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[23] Although Basic does not discuss this point, we note that the purpose stated in the specifications to the Hodnett patent refers principally to the chemical improvement that can be obtained by adding free carbon. The patent does not specifically refer at that point to improved strength and density. Assuming, arguendo, that Hodnett was ignoring these important physical properties, we do not think that this is a basis on which to distinguish Wilson from Hodnett. The fact remains that the evidence tended to establish that the two processes achieve an essentially equivalent result and that the use of either carbon black or graphite was taught in the Hodnett patent.

B

In addition to technical evidence, the parties offered evidence concerning certain "secondary considerations." *Graham, supra,* 383 U.S at 17. Basic pointed particularly to the commercial success of the thermal black process, noting that almost every producer of refractory bricks uses thermal black under license from Basic. These competitors were apparently unable to find a superior process. Of course, commercial success and the satisfaction of long-felt needs are alone not sufficient to establish that the product is the result of invention. *Sakraida, supra,* 425 U.S. at 278-79; *Anderson's Black-Rock, supra,* 396 U.S. at 61; *Phillips Indus. Inc.* v. *State Stove & Mfg. Co.,* 522 F.2d 1137, 1141-42 (6th Cir. 1975). Here, moreover, there was evidence that the consideration received from Harbison-Walker, the largest firm in the business, for its license was of questionable value. There was also evidence that thermal black is the cheapest of the free carbons. Indeed, a 1968 letter to patent counsel indicated that Basic wanted a patent specifying thermal black because of its comparatively low cost. Defendant's Ex. FR at 4. The same letter also indicated that in 1965 when Basic reverted to using thermal black from graphite it did so *purely* for economic reasons. In our view these secondary facts can in no way "tip the scales" in Basic's favor. *American Seating, supra,* 586 F. 2d at 622. They tend, instead, to tip the scales in Eltra's favor.

In view of the fact that the prior art had already disclosed the usefulness of carbon generally, and carbon blacks in particular, and since the Wilson patent changed neither the quantities of carbon nor the basic process of particle stuffing from the Hodnett patent, and also given the fact that Wilson's process was not shown to perform demonstrably better than Hodnett's, we believe that the selection of thermal black as a preferred additive is not a patentable difference. *Cf. Lucerne Products, Inc.* v. *Cutler-Hammer, Inc.,* 568 F.2d 784, 798 (6th Cir. 1977). We are confirmed in this view by the other evidence which tended to show that economics, not invention, may have been the real source of this patent. But a cost savings is not a patentable difference. It is not a substitute for invention. *Sakraida, supra,* 425 U.S. at 282-83; *Reynolds Metals, supra.* 548 F.2d at 162. In addition, there can be no "exercise of the inventive faculty," *McClain* v. *Ortmayer,* 141 U.S. 419, 427 (1891), where one merely substitutes one material for another. *Graham, supra,* 383 U.S. at 11; *Hotchkiss* v. *Greenwood,* 52 U.S. (11 How.) 248 (1851). In our opinion this case involves at most "improvement . . . [which is] the work of the skillful mechanic not that of the inventor." *Id.* at 267. It was therefore obvious under 35 U.S.C. § 103.[24]

III

Although our holding that the patent is invalid necessarily eliminates the District Court's award of treble damages and attorney's fees, we believe those awards deserve specific comment because of the serious error committed below. In our opinion, even if the patent were valid there is no basis in the record of this case for either award.

The statutory provision relating to damages is 35 U.S.C. § 284. It provides:

> § 284. Damages
>
> Upon finding for the claimant the court shall award the claimant damages adequate to compensate for the infringement, but in no event less than a reasonable royalty for the use made of the invention by the infringer, together with interest and costs as fixed by the court.
>
> When the damages are not found by a jury, the court shall assess them. In either event the court may

[24] This holding renders it unnecessary to discuss Eltra's claim that Basic committed fraud on the patent office. Therefore we express no opinion on its merits.

> increase the damages up to three times the amount found or assessed.
>
> The court may receive expert testimony as an aid to the determination of damages or of what royalty would be reasonable under the circumstances.

To support its extraordinary award the District Court stated:

> The evidence in this case leaves no doubt in the Court's mind that the plaintiff's infringement in this case was deliberate and intentional. To condone such misconduct would set an example that would seriously weaken the patent system. The Court will, therefore, when the amount of damages has been determined, either by its assessment or upon stipulation of the parties, increase it three times.
>
> [App. 477.]

In order to support such an increased, punitive award there must be a finding that the infringement was wilful. *H. K. Porter Co., Inc.* v. *Goodyear Tire & Rubber Co.*, 536 F.2d 1115, 1124 (6th Cir. 1976). The existence of honest doubt concerning the validity of a patent precludes a finding of wifulness. *Id.; General Electric Co.* v. *Sciaky Bros., Inc.*, 415 F.2d 1068, 1073 (6th Cir. 1969). As this Court stated in *Enterprise Mfg. Co.* v. *Shakespeare Co.*, 141 F.2d 916, 921 (6th Cir. 1944):

> If honestly mistaken as to a reasonably debatable question of validity, an infringer should not be made to smart in punitive damages. Compensatory damages constitute adequate remuneration for invasion of a patentee's property rights, unless the refusal of the infringer to bow to the presumptive validity of an issued patent is consciously wrongful. A court of equity, exercising patent jurisdiction, does not readily infer wrong motivation upon the part of those resisting the validity of patent claims. Patentees generally entertain suspicion that those who challenge their claims are deliberate malefactors. However bona fide, such suspicions produce no legal effect, unless sustained by evidence substantiating suspicion as truth.

In this case Eltra's Narco division stopped paying royalties after it learned that Harbison-Walker, the dominant firm in the business, had questioned the validity of the patent. The opinion of outside counsel was also sought and it was to the effect that the patent was invalid. In this context Eltra's Narco division ceased its royalty payments and attempted to renegotiate the license. Only after these negotiations broke down, and after it learned that Harbison-Walker had obtained a royalty-free license did Eltra bring suit. Its "infringement" was thus "intentional" in the sense that it was not inadvertent. But a licensee is not required to pay royalties when it successfully challenges a patent's validity. *Lear, Inc.* v. *Adkins*, 395 U.S. 653, 671-74 (1969). These facts simply do not make out a wilful infringement so that there was no basis whatever on which to award damages in excess of those intended to compensate Basic for its loss.

We can similarly find no plausible basis for the District Court's award of attorney's fees. The pertinent statute is 35 U.S.C. § 285. It provides simply:

> § 285. Attorney fees
>
> The court in exceptional cases may award reasonable attorney fees to the prevailing party.

The District Court found this case to be exceptional, stating:

> The defendant also asks for an allowance of attorneys fees. 35 U.S.C. § 285 provides that in exceptional cases the Court may award reasonable attorney fees. This case is made exceptional by the insistence of the plaintiff that the Wilson Patent and its re-issue were obtained by fraud and deceit practiced by the defendant upon the Patent Office. To make such a charge not only impugns the party charged, but also reflects on the Patent Office and its staff. It implies either lack of competence or lack of effort, or both, since it is ordinarily very difficult to practice fraud on one who is reasonably skilled in his business and is paying proper attention to it.

> It is elementary in law that one who seeks to establish fraud must do so by clear and convincing evidence. A person should not make damaging accusations without a very strong basis for believing them true. To make such an accusation as a smoke screen to divert attention from, or to attempt to confuse, the basic issues of patent validity or infringement ought not to be permitted.
>
> [App. 477.]

In order to support an award of attorney's fees in a patent case we have previously held that there must be a showing of conduct which is unfair, in bad faith, inequitable, or unconscionable. *Deyerle* v. *Wright Mfg. Co.*, 496 F.2d 45, 54-55 (6th Cir. 1974); *Uniflow Mfg. Co.* v. *King-Seeley Thermos Co.*, 428 F.2d 335, 341 (6th Cir.), *cert. denied*, 400 U.S. 943 (1970); *Hoge Warren Zimmermann Co.* v. *Nourse & Co.*, 293 F.2d 779, 784 (1961).

The District Court's award was based on the fact that, in the Court's view, Basic and the patent office had been "impugned" by an unproved allegation of fraud on the patent office. In our opinion only the most frivolous of allegations should give rise to an award of attorney's fees under section 285. Normally awards under this provision are based on the conduct of the parties, not on the quality of their proof. *E.g., Deyerle, supra.*

In this case, while we offer no opinion as to the merits of Eltra's claim of fraud on the patent office, we cannot view the allegation as frivolous. As explained above, Basic misrepresented the thrust of the Hyde affidavit in its prosecution of the reissue application. In addition, there was some evidence that Basic "rigged" the Hyde results by intentionally using coarse graphite in its comparative tests, even though Basic's officials were aware that fine graphite would yield different results. In the face of these facts the District Court erred in awarding attorney's fees to Basic.

The judgment of the District Court is reversed.

Appendix B

FILED
JUN 18 1979
JOHN P. HEHMAN, Clerk

No. 77-3364

UNITED STATES COURT OF APPEALS

FOR THE SIXTH CIRCUIT

ELTRA CORPORATION
Plaintiff-Appellant

v.

BASIC INCORPORATED
Defendant-Appellee

ORDER

The last paragraph of footnote 3 on page three of our slip opinion is hereby corrected so as to read:

In *Bolkcom v. Carborundum Co.*, 523 F. 2d 492 (6th Cir. 1975), *cert. denied*, 425 U. S. 951 (1976), we stated on page 502:

> The Supreme Court has made it clear that this section is intended only to permit the reissue of a new patent for *the same invention* as that disclosed in the original patent in order to permit the correction of an innocent inadvertent defect or omission. It is not intended to permit the patentee to broaden the claims of the original patent. (Emphasis in quotation).

It is further ordered that on page 10, line 8 of our slip opinion the sentence reading: To be nonobvious, the advancement must be the product of "inventive genius." be changed so as to read as follows: To be nonobvious, some prior decisions held that the advancement must be the product of "inventive genius."

ENTERED BY ORDER OF THE COURT

JOHN P. HEHMAN
Clerk

Appendix C

IN THE UNITED STATES DISTRICT COURT
FOR THE NORTHERN DISTRICT OF OHIO
WESTERN DIVISION

Civil No. C 73-483

ELTRA CORPORATION,

Plaintiff,

vs.

BASIC, INC.,

Defendant.

Civil No. C 74-26

BASIC, INC.,

Plaintiff,

vs.

ELTRA CORPORATION,

Defendant.

MEMORANDUM

(Filed March 17, 1977)

YOUNG, J:

Civil action C 73-483 was originally commenced by the plaintiff Eltra Corporation (hereafter referred to as plaintiff) seeking a declaratory judgment that a certain patent and reissue patent (hereafter referred to as the Wilson patent) owned by the defendant Basic, Incorporated (hereafter referred to as the defendant) was invalid and was not being infringed by the plaintiff.

Shortly thereafter, the defendant filed an action, Civil No. C 74-26, for infringement of the Wilson patent against the plaintiff in the Eastern Division of this Court. Defendant's case was ordered transferred to the Western Division and consolidated with the present case, and the matter thereafter proceeded as if the defendant's case were a cross-action in the plaintiff's case.

After the usual period of discovery and pre-trial conferences, the matter finally was set for trial to the Court on September 20, 1976, and was tried, commencing on that day, and concluding on the morning of September 23. The matter was argued by briefs, which ultimately were filed, placing the matter in position to be decided.

Although the trial of patent cases is usually somewhat complicated, this one has been made more than usually so by the fact of the reissue of the patent, and the plaintiff's tendency to substitute pejorative adjectives for facts in the briefs.

The invention involved in the Wilson patent deals with the making of pitch-bonded refractory bricks. These bricks are used to line the furnaces in which steel is made by the basic oxygen process. This method of steel-making did not come into general use in this country until the early nineteen-fifties, following the conclusion of World War II. Before that time, steel was made either by the basic open-hearth process or the acid Bessemer process. While all steel-making requires the use of refractory materials for lining the furnaces, the old processes did not require the type of refractory brick involved in this litigation.

Pitch-bonded refractories have been in use for a century or more for various purposes. Essentially they consist of some sort of material resistant to high temperatures which is ground up, mixed with some variety of pitch, formed into shapes, stabilized either by compressing, heating, or both. In the type involved here, the refractory material usually consists of dead-burned magnesia or dolomite, and the stabilization is by forming under pressure and heating for a relative short time at quite high temperatures.

The vessels used for making steel by the basic oxygen process are very large. They consist of a steel outer shell lined with refractory bricks to keep it from being dissolved by the molten metal inside. Putting the refractory lining into one of these vessels is a very costly and time-consuming process. During the time required for re-lining, the vessel is out of use, and cannot make either steel or money.

As a result of this, the various manufacturers of refractories, including the defendant and the plaintiff's NARCO division, were, at the time the Wilson patent was issued and re-issued, engaged in much research aimed at developing refractory bricks which would last longer before having to be replaced in the vessels they lined.

With this background, the facts of the present case can be examined. As usual, in patent cases, the evidence is voluminous and conflicting in many details. The parties have examined and analyzed it at great length in their printed post trial briefs, which total one hundred fifty-three pages in length.

It is not necessary in this opinion to make another extended analysis of the evidence. This opinion, which will serve as the Court's findings of fact and conclusions of law, will set forth the Court's resolution of the ultimate factual and legal issues.

The basic rule is that a patent is presumed to be valid, and those who attack its validity, in order to succeed, must establish their case by clear and convincing evidence.

The plaintiff argues: first, that the Wilson patent is invalid because it was obvious in view of the prior art; second, that the Wilson patent and more specifically its re-issue, were accomplished by fraud and deceit practiced

upon the Patent Office and its Examiner, and third, the plaintiff is not infringing the patent anyway.

The plaintiff fails to establish any one of these propositions at all, much less by clear and convincing evidence. To understand this conclusion, it is necessary to consider what it was that Wilson invented and patented.

As stated above, pitch-bonded refractories had been in use for a long time. With the advent of the basic oxygen process of steelmaking, their manufacture became a large and highly competitive business. The parties, and other manufacturers, put their research departments to work on the problem. Basically, the research consisted of testing the effect of adding various quantities of other materials to the mixture of pitch and refractory, and testing the effect on the resultant brick. The principal material tested was some form of carbon. This Protean element has several allotropic forms, and a large number of varieties of each form, with widely varying characteristics.

When the inventor Wilson came to work for the defendant, he started to experiment with various forms of finely divided carbon as an additive to the pitch and refractory. In doing so he went beyond the scope of the materials available in the defendant's laboratory. Although his experimentation was discouraged by his fellow employees as being futile and unlikely to lead to any useful result, he got some lamp-black, or "thermal" black, at the local hardware store, and experimented with it. He found that thermal blacks of certain physical characteristics had marked effect in improving the performance of the pitch-bonded refractories. There was evidence from which it can be concluded that some chemical reactions took place between the thermal black and the pitch which caused the latter to become very much harder and stiffer than normal.

A patent was sought upon Wilson's discovery, and after some difficulties, it was issued. The original Wilson

patent was broad in its claims, and several other forms of carbon than thermal black were covered by it.

While Wilson was conducting his experiments, and before, an inventor named Hodnett obtained a Canadian patent which dealth with the same subject matter. At the time that the Hodnett patent was issued, it was picked up routinely by some of the defendant's employees, who got a copy of it, and then sought a license under it. The owner offered to license the defendant for a flat royalty of one dollar per year. The defendant, acting administratively, sent the owner a check for seventeen dollars, covering royalties for the life of the patent, and promptly forgot about the matter.

Plaintiff argues vociferously that no one could possibly forget about so important a matter as a patent license, even a seventeen dollar one, and that the defendant actually concealed the existence of the Hodnett Patent Office for the purpose and with the effect of deceiving and defrauding the Patent Office into the issuing and reissuing of the Wilson Patent. The essential elements of fraud and deceit are: first, that a representation was made as a statement of fact; second, that it was untrue and known to be untrue by the party making it, or carelessly made; third, that it was made with intent to deceive and for the purpose of inducing the other party to act on it; and fourth, that the other party did rely and act upon it to his damage. 37 Am.Jur. 2d 34, *Fraud* § 12. The plaintiff failed to show any of these elements in fact.

Moreover, fraud on the Patent Office involves two elements: first, an element of wilful, wrongful intent before the Patent Office; second, that the patent would not have issued but for the wrongful conduct of the patent applicant. *In re Frost Litigation*, 398 F. Supp. 1353 (D. Del. 1975). The fraud must be established by clear, unequivocal and convincing evidence. *Schnadig Corp.* v. *Gaines Manufacturing Company, Inc.*, 494 F.2d 383 (6th

Cir. 1974); *Dickstein* v. *Seventy Corp.*, 522 F.2d 1294 (6th Cir. 1975).

The most that can be said for the plaintiff's contentions of fraud is that the defendant innocently overlooked the Hodnett Patent during the prosecution of the application for the Wilson Patent. The evidence admits of no other conclusion, for obviously if the plaintiff had been aware of the Hodnett Patent and disclosed it to begin with, it would have avoided the trouble and expense of seeking the re-issue patent. The plaintiff's claims in this regard are a good example of the problem discussed disapprovingly by the Eighth Circuit Court of Appeals in *Pfizer* v. *International Rectifier Corp.*, 538 F.2d 180 (8th Cir.), *cert. denied*, — U.S. —, 97 S.Ct. 738 (1976), where it said:

> A patentee's oversights are easily magnified out of proportion by one accused of infringement seeking to escape the reach of the patent by hostily combing the inventor's files in liberal pretrial proceedings.

The evidence does not support this position at all, much less by the clear and convincing force necessary to establish either fraud or the invalidity of a patent.

While certain broad language in both the Hodnett and Wilson patents refers to a wide spectrum of forms of finely divided carbon, what the Hodnett patent really covers is the use of certain forms of graphite. The Wilson patent excludes the particular variety of graphite covered by the Hodnett patent, since Wilson's experiments demonstrated that the variety of graphite decreased the density of the pitch-bonded refractory bricks, an undesirable characteristic.

When the defendant finally became conscious of the possibility of a conflict between the Wilson and Hodnett patents, it sought and obtained the reissue in order to clarify the fact that the inventions covered by the two patents were different. The Patent Examiners could not have been deceived in connection with the re-issue of the Wilson patent, and obviously were not deceived.

The defendant [Sic, plaintiff] also attempted to confuse matters by offering testimony concerning the making of carbon electrodes, which also involve the use of pitch and various forms of finely ground carbon, and the Swallen patent which deals with these so-called "carbon bodies." This is totally irrelevant, if for no other reason than that electrodes use little or no refractory material such as dead-burned magnesia or dolomite, and are made by processes almost entirely different from those used in making the refractory bricks involved here.

Plaintiff's experts attempted to demonstrate by use of spheroids of various sizes some of the physical characteristics of making materials increasingly dense. While this was interesting from a theoretical standpoint, the particles of ground refractory used in the bricks involved here are not spheroids of relatively uniform size, but completely irregular both in size and shape. Consequently this testimony was without probate force upon the issues involved here.

The realities of the matter, as shown beyond any doubt by the evidence, are that Wilson's invention was something entirely new and different from prior art. Not even in hindsight can it be truly said that it was simply a combination of old principles which any person skilled in the art would naturally make. Both before and since the invention, numbers of experts, including plaintiff's, have tried to get the patent's results by other means, with no success whatsoever.

In a highly competitive field, the bricks made by the use of Wilson's invention immediately established themselves as far superior to anything also on the market. All the other manufacturers of pitch-bonded refractories, including the plaintiff, very promptly sought licenses, not

of the dollar-a-year variety, but ones which pay substantial royalties, and except for the plaintiff, have continued to pay the royalties. Nobody has yet come up with anything as good as Wilson's invention. This is strong evidence supporting the validity of the patent.

There still remains the issue of whether or not the plaintiff is infringing the defendant's patent. This issue depends upon one vary narrow matter, the particle size of the thermal black employed by the plaintiff in its manufacture of refractory bricks.

Defendant's patent applies to the use of thermal blacks having an average particle size from about 180 to about 470 millimicrons. Defendant claims that the average particle size of the thermal black it uses, called "Huber N-990" is about 522 millimicrons. This claim is based on the unsupported testimony of the witness Ulmer. The evidence leaves no doubt whatever in the Court's mind that the average size of "Huber N-990" is from 300 to 320 millimicrons, and thus clearly within coverage of the Wilson patent. This is a clear infringement of the patent, and requires the issuance of an injunction restraining the defendant from continuing to infringe, and an award of damages for the past infringement.

Since the trial held was concerned only with the various liability issues, the matter will have to be set for hearing upon the issue of the amount of damages unless the parties can stipulate to the amount thereof.

35 U.S.C. § 284 provides that the amount of damages for infringement shall in no event be less than a reasonable royalty for the use made of the invention by the infringer, together with interest and costs fixed by the court. This statute also provides that the court may increase up to three times the amount found or assessed.

The evidence in this case leaves no doubt in the Court's mind that the plaintiff's infringement in this case was deliberate and intentional. To condone such misconduct would set an example that would seriously weaken the patent system. The Court will, therefore, when the amount of damages has been determined, either by its assessment or upon stipulation of the parties, increase it three times.

The defendant also asks for an allowance of attorney's fees. 35 US.C. § 285 provides that in exceptional cases the Court may award reasonable attorney fees. This case is made exceptional by the insistence of the plaintiff that the Wilson Patent and its re-issue were obtained by fraud and deceit practiced by the defendant upon the Patent Office. To make such a charge not only impugns the party charged, but also reflects on the Patent Office and its staff. It implies either lack of competence or lack of effort, or both, since it is ordinarily very difficult to practice fraud on one who is reasonably skilled in his business and is paying proper attention to it.

It is elementary in law that one who seeks to establish fraud must do so by clear and convincing evidence. A person should not make damaging accusations without a very strong basis for believing them true. To make such an accusation as a smoke screen to divert attention from, or to attempt to confuse, the basic issues of patent validity or infringement ought not to be permitted. The Court will, therefore, make an award to the defendant of a reasonable sum to cover its attorney's fees and expenses in the defense of this action. Again there is no evidence before the Court upon which to base an award of attorney's fees. If the amount cannot be stipulated, the Court will hear evidence and determine the proper amount.

The defendant may draft an order expressive of the Court's findings here, and submit the same pursuant to L. Civ. R. 5(b).

/s/ DON J. YOUNG
United States District Judge

Toledo, Ohio March 16, 1977.

Appendix D

IN THE UNITED STATES DISTRICT COURT
FOR THE NORTHERN DISTRICT OF OHIO
WESTERN DIVISION

CIVIL NO. C 73-483
CIVIL NO. C 74-26

[CAPTION OMITTED]

JUDGMENT ENTRY and ORDER

(Filed April 8, 1977)

This action came for trial before the Court, Honorable Don J. Young, United States District Judge, presiding, and the issues having been fully tried and a decision having been duly rendered,

It is Ordered and Adjudged that:

1. Judgment be entered for Defendant, Basic Incorporated, and against Plaintiff, Eltra Corporation;

2. All of the claims of reissue patent Re 27,111 are valid and enforceable;

3. The Plaintiff, Eltra Corporation, has infringed claims 2, 4-7, 11, 14, 16 and 21 of reissue patent Re 27,111 by its manufacture and sale of pitch-bonded refractory bricks containing thermal black, including the thermal blacks identified as Sterling MT and "Huber N-990".

4. A writ of injunction issue out of and under the seal of this Court directed to said Plaintiff, Eltra Corpora-

tion, and its successors, its officers, agents, attorneys, employees, associates and privies enjoining and restraining them and each of them from directly or indirectly infringing in any of the claims of reissue patent Re 27,111 during its term, and from offering or advertising to do so and from aiding or abetting or in any way contributing to the infringement of any of the claims of said patent;

5. Defendant, Basic Incorporated, recover damages including (a) an amount not less than a reasonable royalty from the Plaintiff, Eltra Corporation, for infringement of claims 2, 4-7, 11, 14, 16 and 21 of reissue patent Re 27,111 which has taken place since the termination of the license agreement between the parties, and (b) an amount for unpaid royalties which accrued under said license prior to its termination, together with interest on said amounts computed at the rate of 6 percent per annum from dates to be fixed by court;

6. The amount of said damages to be paid by Plaintiff, Eltra Corporation, to Defendant, Basic Incorporated, shall be trebled;

7. Defendant, Basic Incorporated, recover from Plaintiff, Eltra Corporation, a reasonable sum to cover its attorney's fees and expenses in the defense of this action;

8. The Defendant, Basic Incorporated, recover from the Plaintiff, Eltra Corporation, its costs and disbursements in this action to be taxed by the Clerk;

9. An accounting be conducted, at a date to be ordered by the Court, for the purpose of fixing the amount of the damages and attorney's fees and expenses due hereunder; and

10. The injunction and accounting herein ordered shall be and hereby are stayed pending the disposition of

appellate proceedings herein, conditioned upon (a) such appellate proceedings being diligently prosecuted by the Plaintiff, Eltra Corporation, and (b) the posting with the Clerk of the Court within ten days hereof of a supersedeas bond in the sum of $1,000.00.

Dated at Toledo, Ohio, this 6th day of April, 1977.

/s/ DON J. YOUNG
United States District Judge

Approved as to form:

/s/ FRANCIS X. GORMAN
Attorney for Defendant

/s/ JOHN C. PURDUE
Attorney for Plaintiff

United States Patent Office Re. 27,111
Reissued Mar. 30, 1971

27,111
PITCH-BONDED REFRACTORY COMPOSITION

Roger E. Wilson, Silver Spring, Md., assignor to
Basic Incorporated, Cleveland, Ohio

Original No. 3,236,664, dated Feb. 22, 1966, Ser. No. 187,188, Apr. 13, 1962. Application for reissue Mar. 19, 1969, Ser. No. 822,075
Int. Cl. C04b 35/04, 35/52
U.S. Cl. 106—56 18 Claims

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

ABSTRACT OF THE DISCLOSURE

A pitch-bonded refractory composition having high strength and increased density comprising basic refractory particles, about 4% to about 10% by weight based on the weight of the total admixture of a carbonaceous material to bind said particles together, and approximately 0.5 to about 10% by weight based on the weight of the total admixture of a finely divided carbon black, at least a part of said carbon black being thermal black.

The present invention relates to a bonded refractory and, more particularly, to a carbon-bonded dead-burned refractory having improved physical properties for use at elevated temperatures.

The change within the steel producing industry from the open-hearth process of making steel to the relatively new basic oxygen steel-making processes has made demands upon the refractory industry for new and improved furnace lining materials. Preformed brick or block refractories and ramming mixes compounded from dead-burned granular materials such as dead-burned dolomite, dead-burned magnesia, or mixtures thereof, and bonded with a carbonaceous binder obtained from coal-tar pitch have been used as the refractories for these new basic oxygen converters and for other steel-making furnaces. Ever increasing demands, however, by the steel producers for increased furnace life of these pitch-bonded refractory materials have necessitated the continued improvement of such refractories.

The use of coal-tar pitch as a carbonaceous binder capable of undergoing a pyrolytic decomposition to form a carbon bond for various high-temperature-resistant products has long been practiced in certain fields of manufacture and is currently being used in the production of specialized refractory materials. In accordance with the present invention, substantial improvements in the furnace service life of these pitch-bonded granular basic refractories, such as dead-burned dolomite or dead-burned magnesia, can be made by incorporating relatively small amounts of carbon black into the granular refractory formulation.

It is, therefore, a principal object of the present invention to provide an improved method of forming a bonded refractory and the refractory produced thereby.

Another object is to provide an improved method of forming a green, unfired pitch-bonded basic refractory, which may be stored as such if desired, and later baked pyrolytically to decompose the pitch and form a carbon-bonded refractory.

A further object is to provide an improved coal tar pitch-bonded basic refractory composed, for example, of dead-burned dolomite, dead-burned magnesia, or mixtures thereof which may be used as a ramming mix.

A still further object is to provide an improved ramming mix as just described which can be molded or pressed into

various desired shapes for use as brick or block in a basic oxygen converter or other steel producing furnaces.

Other objects of the invention will become apparent as the description proceeds.

To the accomplishment of the foregoing and related ends, the invention consists of the features hereinafter fully described and particularly pointed out in the claims, the following disclosure describing in detail the invention, such disclosure illustrating, however, but one or more of the various ways in which the invention may be practiced.

In carrying out the present invention, refractory particles are admixed with a carbonaceous material, capable of pyrolytically decomposing to form a carbon bond, and also with a relatively small amount of carbon such as carbon black. The admixture may be used in this form, for example, as a ramming mix. Usually, however, the admixture is shaped such as by pressure into a desired form, for instance, a brick or block form. A "green" ramming mix or shaped article may either be used immediately or stored and later employed for the repair or lining, respectively, of a furnace wall or bottom. By subsequently bringing the furnace to an operating temperature, the carbonaceous material in the mix or brick is pyrolytically decomposed or "coked" and forms a carbon bond within the mix or brick as installed in the furnace. If desired, especially in the case of the brick, the coking can be performed separately prior to installation in a furnace.

In both the green and coked or baked states, the presence of the carbon black has been found to improve the physical properties of the mix or blend particularly as to oxidation, crushing strength (bond strength), and density. The exact function of the added powdered carbon material in improving the bonded refractory is not clearly known. The introduction of carbon into the granular refractory formulation apparently increases the binding properties of the pitch bond and as a result reinforces the structure of the carbon bond formed by the pyrolytic cracking of the pitch.

Refractory particles employed in accordance with the present invention are desirably dead-burned refractories, that is, those that have been calcined to a dense sintered state. Preferably basic refractories are employed such as dead-burned dolomite, dead-burned magnesia, and mixtures thereof.

As indicated, the carbonaceous material employed is one which leaves a carbon residue when subjected to pyrolytic decomposition or cracking. This may be at temperatures ranging from about 700° F. to about 1850° F. Within this temperature range, a carbon film is formed around and between the granular refractory particles by the cracking of the carbonaceous material to bond the particles one to another. The carbon film formation typically takes place inwardly from an exposed surface of the refractory, for example, by the heat of a steel-making reaction within a basic oxygen converter or furnace, the inward extent depending on conditions of exposure. Evaluation of any pitch-bonded refractory is, therefore, performed on specimens which have been heated to undergo pyrolytic decomposition or "coking" of the pitch binder, using the compressive crushing strength of the resulting refractories as a criterion of comparison.

Preferably, the carbonaceous materials employed are pitches and especially those derived from coal tar. For example, such coal tar pitches have softening points of about 40° C. to about 100° C. as measured by the A.S.T.M. Method of Test D-36-26. In some instances coal tar itself is used for bonding such refractories, although usually coal tar pitch is preferred as it is essentially free of the lower boiling constituents ordinarily found in coal tar. Some of the bituminous asphalts may be used provided they have the property of decomposing

pyrolytically to form a substantial carbon residue. Many asphalts do not have this property but rather distill in their entirety upon heating and therefore are not usable. Consequently, the coal tar pitches are more generally used as the binder in this type of refractory brick, since such pitches are less expensive and have the desirable characteristic of yielding a larger proportion of carbon upon cracking.

All of the various kinds of carbon blacks known in the art can be used. Other pulverulent carbons of non-cubic crystalline structure may also be used in practicing the invention. For example, pulverized finely-divided coal and coke or graphite may be used, but such carbons are not as efficacious as carbon blacks. Exemplary carbon blacks include lamp blacks, channel blacks, gas or oil-furnace combustion blacks, thermal blacks, acetylene blacks, and the like. Some of these blacks are also known as impingement blacks. Further, such blacks may be used individually or in combination in being added to a granular basic refractory formulation to improve the coked crushing strength of the product along with the density and other desirable properties.

The designations of different types of carbon blacks mentioned in the preceding paragraph are all art recognized terms. Descriptions of carbon blacks may be found, for example, in "Encyclopedia of Chemical Technology," by Kirk and Othmer, The Interscience Encyclopedia, Inc., New York, 1949, volume 3, pages 34 to 60. A further description of kinds and sources of carbon blacks is given in U.S. Patent No. 2,527,593 to Swallen et al. Both the text and patent citations are hereby incorporated by reference.

Carbon blacks comprise a group of extremely finely divided types of non-crystalline carbon composed of particle sizes at sub-grinding levels. These blacks are also known as colloidal carbons because of their small particle sizes and behavior in aqueous and liquid organic media. However, there are some carbon blacks also within the contemplation of the present invention whose particle size may be outside what is generally considered to be the upper limit of colloidal sizes. The carbon blacks include products from various commercial processes in which hydrocarbons are subjected to partial combustion and to a non-oxidizing thermal treatment. Several types are produced which differ from one another in particle size. The various types may differ markedly with little regard to particle size in other respects, for example, some blacks are composed of very dense well defined particles, while others consist of rather flocculent particles agglomerated into porous masses.

The carbon blacks which have been found to be most useful in practicing the invention have properties within the following ranges:

Average particle diameter	20 to 500 millimicrons.
Surface area	5 to 375 square meters per gram.
Volatile content	Less than 14% by weight.
Fixed carbon	85 to 99.5% by weight.

The following Table A lists specific kinds of carbon blacks which have been used:

TABLE A

Carbon type	Surface area, M^2/g.	Particle Diameter (mμ)	Oil absorption, /100 Phr.	Volatile content, percent	Fixed carbon, percent	pH	Apparent density, /Ft.³
Regular channel	100-140	22-29	120-130	5.0	95.0	4.5-5	10-14
Medium flow channel	200-210	20-23	105-130	7-7.5	92.5-93	4.0	11
Low flow channel	250-300	17-23	65-94	13-15	87-85	3.5	12
Conductive oil furnace	125-210	21-29	130-250	1.5-2.0	98-98.5	8-8.5	6
Oil furnace	30-125	29-56	80-115	1-1.5	99-98.5	8.5-9	
Gas furnace	23-30	60-80	70-80	1.0	99.0	9.5-10	18
Thermal	6-13	180-470	32-36	0.5	99-5	8.5-9	31-33

The surface areas listed were determined by the nitrogen adsorption using the method of Brunauer-Emmett-Teller, known in the art. The particle diameters are arithmetic mean diameters measured from electron micrographs of the blacks. The oil absorptions were measured by the "Cabot Coherent Ball Method" using linseed oil. This value is a relative measure of the structure of the black and oil needed for its saturation. The volatile content of a black is related to the amount of chemisorbed oxygen which is present on the carbon surface. The pH value of carbon black is determined with a glass electrode in a carbon black-water sludge, A.S.T.M. designation: D-1512. Under these condtions the pH is related to the amount of carbon oxygen complexes on the surface of the carbon black. A relatively high amount of these complexes results in a low pH. The apparent density indicates the amount of storage or shipping space a given black will occupy.

Carbon blacks of the type shown in Table A are manufactured by the Cabot Corporation of Boston, Massachusetts, and sold under the following trade names: Elf, Mogul, Vulcan, and Sterling. Various grade designations may accompany such trade names.

The amount of carbonaceous material such as coal tar pitch used to bond refractory particles is important in that higher contents of pitch and the like provide better coked strength and better performance of the refractory in a furnace. However, the increased amounts of pitch likewise increase the difficulty of manufacture and storage of the bonded refractory.

For example, if too much pitch is used, the mixed particles and pitch are difficult to handle because the mixture becomes so sticky. Further, such a mixture does not retain a pressed shape. Since the coal tar pitch is molten at this stage, the particles-pitch mixture is too fluid to handle if excess pitch is present. The mixture behaves as a plastic deformable glob which does not hold its shape. Also when released from a mold, the pressure decrease tends to result in cracks. On the other hand, if the mold parts or other apparatus used to impart the shape is maintained in a closed position until the pitch cools and sets, not only does sticking of the refractory to the mold parts result, but the overall process becomes much too slow for commercial application. Accordingly, for a given refractory there is a maximum pitch tolerance or capacity which balances the extremes of sufficient pitch to provide a desired bond and a mixture which retains a shape imparted by pressing.

As one modification of the present invention, it has been found that a blend of two particular carbon blacks, employed as an additive as herein disclosed, increases the pitch tolerance or allowable maximum capacity, other factors being the same. Such a blend includes a high oil absorbing carbon black and a thermal carbon black, especially a fine thermal black. This blend provides the greatest increase in green and coked strength of a refractory over any other carbon black used separately.

The high oil aborbing black may be either a long flow channel carbon black or a conductive oil furnace carbon black. In either case, an absorptivity of at least 85 pounds of oil per 100 pounds of black is preferred. Normally the thermal carbon blacks, which are of relatively coarser particle size, are desirable from the standpoint of imparting strength. However, thermal blacks are the poorest from the viewpoint of pitch tolerance and may even decrease pitch tolerance. Consequently, the stated blend is not only efficacious in providing a desirable strength but also in raising the pitch tolerance of the refractory.

The defined blend of carbon blacks may comprise from about 1:2 to 2:1 parts by weight of the high oil absorbing black to the thermal black, respectively, *or about 66% to about 33% by weight thermal black*. Preferably equal parts by weight of each are used. It is thought that the high oil absorping black contributes the enhanced pitch tolerance, while the thermal black contributes the requisite strength, such that there is a true synergistic cooperation between the two. Increases in permissive pitch content of one percent to 1.5 percent by weight have been possible with the use of the defined blend without being confronted with any of the problems usually attendant such increased use of pitch.

In general, dead-burned basic refractory particles of the type indicated are first blended with a carbon black. Any amount of a carbon black provides some advantage, but usually an amount ranging from about 0.5 percent to about ten percent is used, based on the weight of the total admixture to be ultimately prepared and preferably about one percent to about three percent. The blend or mixture is then heated from about 225° F. to about 325° F., as an example, and then admixed with the carbonaceous material such as coal tar pitch in an amount from about four percent to about 10 percent by weight, also based on the weight of the total admixture. The pitch is preferably preheated to a temperature which renders it only sufficiently fluid to mix readily with the refractory particles.

If the final admixture is not to be used as a ramming mix, it is molded into a desired shape, such as a brick shape, by pressing at high pressure, for example, 10,000 p.s.i., and/or by intensive tamping or vibration. After pressing, the shaped refractory is cooled on suitable flat supports to such a temperature that the pitch stiffens and the refractory is not subject to deformation upon handling. Upon being placed in the furnace or other place of use, the coal tar pitch is converted to a tough and strong carbon bond by rapidly heating the refractory to temperatures of the order of 2000° F. or even to working temperature of the order of 3000° F. As the temperature of the brick mass passes through the zone of 500° F. to 1800° F. the coal tar pitches are cracked or "coked" by pyrolytic reactions such as take place in the cracking towers for petroleum or as occurs in the manufacture of carbon electrodes which also have an initial binder of coal tar pitch. The pyrolytic reactions cause the tar to decompose into a light volatile fraction which distills off leaving a residual carbon material which provides the bond.

If desired, the brick may be "coked" prior to use, by being baked in any suitable furnace provided with a non-oxidizing atmosphere. By heating, for instance, to 700° F. to 1800° F. over a period of 12 to 72 hours, depending upon the size of the shape, a partial or complete pyrolytic decomposition of the pitch is obtained leaving a residual tough and strong carbon bond throughout the brick.

In order to demonstrate the invention, the following examples are set forth for the purpose of illustration only. Any specific enumeration or detail mentioned should not be interpreted as a limitation of the invention unless specified as such in one or more of the appended claims and then only in such claim or claims.

In these examples, the bond reinforcement obtained in accordance with the present invention is indicated by comparing the increase in the mechanical coked crushing strength of specimens containing added carbon against specimens containing no carbon additive. The data given in Tables B to E clearly indicate that the added carbon not only increases the coked crushing strength and coked density of the refractory specimens, but also enhances the same properties in specimens which have not been coked and do not as yet have any carbon bond developed by pyrolytic decomposition. All screen sizings given are U.S. Standard; and the indicated percentages are by weight.

Example 1

A mixture of dead-burned dolomite comprising 20 parts by weight of a coarse fraction of which essentially 95 percent passed through a ¾ inch sieve and all of which was retained on a 12 mesh screen, and 40 parts by weight of an intermediate sizing of which essentially 95 percent passed through a 6 mesh sieve and essentially all was retained on a 50 mesh sieve, was heated to approximately 300° F. and thoroughly mixed. Forty parts by weight of finely ground dead-burned magnesia, of which essentially 65 percent passed through a 200 mesh sieve, was then heated to approximately 300° F. and added to the mix. This granular refractory aggregate was tempered with a 5 percent addition of a molten pitch binder having a softening temperature within the range of 80° C. to 85° C. and thoroughly blended. Test specimens measuring 3.5 inches in diameter and about 2 inches in thickness were pressed from the hot (260° F.-280° F.) batch at 10,000 p.s.i. After cooling to room temperature, three of the six specimens pressed from each batch were evaluated in this form, that is, in the "green" state. The remaining three specimens were heated in the absence of oxygen and coked completely througbout the body of the specimens before being measured and compressively crushed.

A substitution of 2 percent of very finely powdered carbons of different types was made for the dead-burned magnesia fines in the above described formulation. The addition of carbon to the admixture was accompanied by a commensurate reduction in the amount of magnesia fines in order to maintain a uniform granulometric distribution among the comparative samples. The carbon was first added to the magnesia fines, milled for 0.5 hour in a pebble mill, the thoroughly blended mix heated to approximately 300° F., and then added to the heated granular dolomite fraction for blending and tempering according to the above described technique. The test results of the carbon types thus evaluated are given in Table B.

Example 2

A mixture of dead-burned dolomite comprising 15 parts by weight of coarse granules passing a ¾ inch sieve but retained on a 0.1875 inch sieve; 22 parts by weight of intermediate sized granules passing 0.1875 inch sieve but retained on a 6 mesh sieve; and 23 parts by weight of finely sized granules essentially passing a 12 mesh sieve was heated to approximately 300° F. and thoroughly blended. Forty parts by weight of heated dead-burned magnesia fines were added to the mixture which was next tempered with 4.5 percent of added molten coal tar pitch binder, having a softening temperature in the range of 80° C. to 85° C., and thoroughly blended. Test cylindrical specimens were pressed and evaluated as described in Example 1.

Substitutions from 1 to 3 percent of a fine thermal carbon black were made for a like amount in the dead-burned magnesia fines. The carbon addition was, as described in Example 1, first made to the magnesia fines, milled, heated, then blended as described. The test results for these substitutions are given in Table C.

Example 3

Using the same granular refractory composition and procedure of Example 2, including the 2 percent carbon substitutions for magnesia fines, the percentages of coal tar pitch were increased. Three different carbon blacks were used in substitution for the magnesia fines. The comparison of test results for the resulting test specimens showing the improved properties of the added carbon containing specimens over those containing no added carbon for various percentages of pitch are given in Table D.

Example 4

It was indicated in Example 3 and in Table D that an increase in the pitch content increases the strength of the refractory, but not as markedly as the substitution of 2 percent fine thermal black for the fine fraction of a granular refractory mixture. The attempts made to increase the pitch content of such mixes produced unworkable, excessively plastic, masses. It was found, however, that small additions of regular channel black carbon to granular refractory mixtures containing fine thermal carbon blacks enable the addition of up to 6 percent pitch, thereby giving the refractory the benefits of an increased pitch content.

Two parts by weight of a carbon black were added to the magnesia fines, milled for ½ hour, heated, blended with the dead-burned dolomite granules, tempered with pitch, and pressed into cylindrical test specimens as described in Examples 1 through 3. The carbon black of the present example consisted of fine thermal carbon black, regular channel carbon black, or mixtures thereof. A conductive oil furnace black could have been used in place of the regular channel black. The percentage of pitch added was varied from 4.5 to 6 percent.

Table E gives the test results of multiple carbon type additions for a granular refractory mixture tempered with varying amounts of coal tar pitch.

TABLE B.—CRUSHING STRENGTH AND DENSITY MEASUREMENTS

[Green and coked specimens 3¼" dia. x 2" thick pressed at 5 tons per square inch]

Formulation:	Percent by weight
Dead-burned dolomite, coarse	20
Dead-burned dolomite, intermediate	40
Dead-burned magnesia fines	38-40%
Carbon addition	0-2%
	40

Carbon type*	Percent carbon	Percent pitch	Density, lbs./cu. ft. Green	Density, lbs./cu. ft. Coked	Crushing strength lbs./sq. in. Green	Crushing strength lbs./sq. in. Coked
None—Control	0	5.0	173	163	7,100	3,000
Fine Thermal Black	2	5.0	176	170	10,700	9,000
Do	2	5.0	176	169	9,000	8,000
Regular Channel Black	2	5.0	175	169	8,000	6,400
Long Flow Channel Black	2	5.0	172	167	6,700	5,300

*"Encyclopedia of Chemical Technology," Kirk and Othmer. The Interscience Encyclopedia, Inc., New York, 1949, volume 3, pages 34-60.

In this example, a mixture of dead-burned dolomite consisting of 15 parts by weight of coarse granules sieved to pass a ⅜ inch screen but retained on a 0.1875 inch screen; 22 parts of intermediate sized grains sieved to pass a 0.1875 inch screen but retained on a 6 mesh screen; and 23 parts of the batch composed of sized granules essentially passing a 6 mesh sieve was heated to approximately 300° F. and thoroughly blended. Finely divided dead-burned magnesia comprising 38 parts of the batch, essentially 65 percent of which passed a 200 mesh sieve, was heated to about 300° F. and added to the dolomite fraction.

The adhesive properties of the coal-tar pitch binder for the refractory granules also seem to be increased by the addition of the powdered carbon. Refractory specimens which have not been coked generally show a marked improvement in the green compressive crushing strength over similar specimens to which no carbon additions have been made. As shown in Table C, carbon additions from 1 to 3 percent substantially increase the desirable properties of the pitch-bonded refractory. But up to 10 percent carbon may be added without deleterious results to the refractory.

TABLE C.—CRUSHING STRENGTH AND DENSITY MEASUREMENTS

[Green and coked specimens 3¼" dia. x 2" thick pressed at 5 tons per square inch]

Formulation:	Percent by weight
Dead-burned dolomite, coarse	15
Dead-burned dolomite, intermediate	22
Dead-burned dolomite, fine	23
Dead-burned magnesia fines	37-40%
Carbon addition	0-3%
	40

Carbon type	Percent carbon	Percent pitch	Density, lbs./cu. ft. Green	Density, lbs./cu. ft. Coked	Crushing strength, lbs./sq. in. Green	Crushing strength, lbs./sq. in. Coked
None—control	0.0	4.5	179	167	7,700	2,700
Fine thermal	1.0	4.5	183	174	10,800	6,100
Do	1.5	4.5	184	177	12,000	7,400
Do	2.0	4.5	186	178	12,500	10,175
Do	2.5	4.5	185	177	14,400	8,400
Do	3.0	4.5	180	175	11,600	9,700

TABLE D.—CRUSHING STRENGTH AND DENSITY MEASUREMENTS

[Green and coked specimens 3¼" dia. x 2" thick pressed at 5 tons per square inch]

Formulation:	Percent by weight
Dead-burned dolomite, coarse	15
Dead-burned dolomite, intermediate	22
Dead-burned dolomite, fine	23
Dead-burned magnesia fines	38-40%
Carbon addition	0-2%
	40

Carbon type	Percent carbon	Percent pitch	Density, lbs./cu. ft. Green	Density, lbs./cu. ft. Coked	Crushing strength, lbs./sq. in. Green	Crushing strength, lbs./sq. in. Coked
None—control	0.0	4.5	179	167	7,700	2,700
Fine thermal	2.0	4.5	185.6	178.3	12,500	10,175
None—control	0.0	5.5	183	174	11,150	6,375
Reg. channel black	2.0	5.5	182	175	12,000	10,600
None—control	0.0	6.0	182	176	10,000	8,050
Long flow channel	2.0	6.0	182	177	12,000	11,000

TABLE E.—CRUSHING STRENGTH AND DENSITY MEASUREMENTS

Green and coked specimens 3¼" dia. x 2" thick pressed at 10,000 lbs. per square inch]

Formulation:	Percent by weight
Dead-burned dolomite, coarse	15
Dead-burned dolomite, intermediate	22
Dead-burned dolomite, fine	23
Dead-burned magnesia fines	38
Carbon addition	2

Carbon type	Percent carbon	Percent pitch	Density, lbs./cu. ft. Green	Density, lbs./cu. ft. Coked	Crushing strength, lbs./sq. in. Green	Crushing strength, lbs./sq. in. Coked
Fine thermal	2.0	4.5	185	177	14,000	9,800
Do	1.75	4.5	185	176	11,700	9,800
Long flow channel	0.25					
Fine thermal	1.50	4.5	185	177	13,000	11,000
Long flow channel	0.50					
Do	2.0	5.0	181	176	10,700	7,200
Fine thermal	1.25	5.0	188	178	14,400	9,800
Long flow channel	0.75					
Fine thermal	1.0	5.0	184	177	13,700	9,800
Long flow channel	1.0					
Fine thermal	0.5	5.0	183	175	11,800	7,700
Long flow channel	1.5					
Fine thermal	1.0	5.5	183	173	12,700	10,300
Long flow channel	1.0					
Fine thermal	1.0	6.0	183	174	13,700	9,700
Long flow channel	1.0					

The binder of carbonaceous material is not per se considered novel in this improved pitch-bonded refractory composition, but as its concentration does influence the carbon bond formation, a percentage by weight of 4 percent to about 10 percent is preferably used. Increasing the binder pitch content improves certain properties of the refractory, but powdered carbon additions to these formulations increase the desired properties above those of similar pitch content. Table D compares various pitch concentrations with and without carbon additions.

The nature of the carbon bond is also influenced by the parent carbonaceous material selected for the refractory binder. The pitch binder may be selected on the basis of its softening points, such as

41–44° C.
80–85° C.
90–95° C.
100–105° C.

based on the desired end result, but a pitch having a softening point between 80–85° C. is preferably used.

Other forms embodying the features of the invention may be employed, change being made as regards the features herein disclosed, provided those stated by any of the following claims or the equivalent of such features be employed.

I, therefore, particularly point out and distinctly claim as my invention:

[1. In the method of admixing basic refractory particles with sufficient carbonaceous material capable of pyrolytic decomposition selected from the group consisting of pitch, coal tar and bituminous asphalt to bind said particles together; the improvement which consists of adding to the admixture approximately 0.5 to 10 percent by weight, based on the weight of the total admixture, of powdered carbon black of non-crystalline structure.]

2. In the method of forming a shaped, [green] *grain* refractory article by admixing dead-burned basic refractory particles with sufficient pitch capable of pyrolytic decomposition to bind said particles together and then shaping the admixture by pressure; the improvement which consists of adding approximately 0.5 to 10 percent by weight, based on the weight of the total admixture, of finely divided carbon black to the admixture prior to such shaping [,] *to produce such a shape of increased density and crushing strength, such carbon black having an average particle size of about 20 to about 500 millimicrons and a surface area of from about 5 to about 375 square meters per gram, at least one third of the carbon black being thermal black having an average particle diameter of about 180–470 millimicrons and a surface area of about 6–13 square meters per gram.*

[3. In the method of admixing dead-burned basic refractory particles with sufficient coal tar pitch to bind said particles together and then heating the admixture pyrolytically to decompose the pitch and form a carbon bond for the particles; the improvement which consists of adding to the admixture prior to the heating approximately 0.5 to 10 percent by weight, based on the weight of the total admixture, of powdered carbon black to improve the properties of the resulting bonded refractory.]

4. In the method of bonding dead-burned basic refractory particles one to another by admixing such particles with about 4 percent to about 10 percent by weight of the admixture coal tar pitch and then heating to coke the admixture and form a bonded mass; the improvement which consists of incorporating approximately 0.5 to 10 percent by weight, based on the weight of the total admixture, of powdered carbon black in the admixture prior to heating to improve the useful life of the bonded mass at elevated temperatures[,] *such carbon black having an average particle size of about 20 to about 500 millimicrons and a surface area of from about 5 to about 375 square meters per gram, at least one third of the carbon black being thermal black having an average particle diameter of about 180–470 millimicrons and a surface area of about 6–13 square meters per gram.*

5. In the method of bonding refractory particles selected from the group consisting of dead-burned dolomite, dead-burned magnesia, and mixtures thereof by blending such particles with sufficient coal tar pitch to bind such particles together, shaping such blend, and then heating the resulting shape to a temperature sufficient to decompose pyrolytically the pitch and form a carbon bond; the improvement which consists of adding to the blend prior to the heating from about 0.5 percent to about 10 percent by weight thereof finely divided carbon black[,] *to increase the density and crushing strength of such shape, such carbon black having an average particle size of from about 20 to about 500 millimicrons and a surface area of about 5 to about 375 square meters per gram, at least one third of the carbon black being thermal black having an average particle diameter of about 180–470 millimicrons and a surface area of about 6–13 square meters per gram.*

6. The method of claim 5 wherein such carbon black is selected from the group consisting of lamp blacks, channel blacks, furnace combustion blacks, thermal blacks and acetylene blacks.

7. The method of claim 5 wherein such carbon black has [properties within the following ranges:

Average particle diameter ... 200 to 500 millimicrons.
Surface area ... 5 to 375 square meters per gram.
Volatile content ... Less than 14% by weight.
Fixed carbon ... 85 to 99.5% by weight.]

a volatile content of less than 14 percent by weight and a fixed carbon content of 85 to 99.5 percent by weight.

8. *In the method of bonding refractory particles selected from the group consisting of dead-burned dolomite, dead-burned magnesia and mixtures thereof by blending such particles with sufficient coal tar pitch to bind such particles together, shaping such blend, and then heating the resulting shape to a temperature sufficient to decompose pyrolytically the pitch and form a carbon bond; the improvement which consists of adding to the blend prior to the heating from about 0.5 percent to about 10 percent by weight thereof finely divided carbon black* [The method of claim 5 wherein], such carbon black [consists] *consisting* essentially of a blend of high oil absorbing carbon black and a thermal carbon black.

9. *In the method of bonding refractory particles selected from the group consisting of dead-burned dolomite, dead-burned magnesia and mixtures thereof by blending such particles with sufficient coal tar pitch to bind such particles together, shaping such blend, and then heating the resulting shape to a temperature sufficient to decompose pyrolytically the pitch and form a carbon bond; the improvement which consists of adding to the blend prior to the heating from about 0.5 percent to about 10 percent by weight thereof finely divided carbon black* [The method of claim 5 wherein], such carbon black [consists] *consisting* essentially of a blend of a high oil absorbing carbon black having an oil absorption of at least 85 pounds of oil per 100 pounds of black and a thermal carbon black, said carbon black being present within a weight ratio of 2:1 to 1:2, respectively.

10. *In the method of bonding refractory particles selected from the group consisting of dead-burned dolomite, dead-burned magnesia and mixtures thereof by blending such particles with sufficient coal tar pitch to bind such particles together, shaping such blend, and then heating the resulting shape to a temperature sufficient to decompose pyrolytically the pitch and form a carbon bond; the improvement which consists of adding to the blend prior to the heating from about 0.5 percent to about 10 percent by weight thereof finely divided carbon black* [The method of claim 5 wherein], such carbon black [consists] *consisting* essentially of a blend of substantially equal parts by weight of a high oil absorbing carbon black selected from the group consisting of a conductive oil furnace carbon black and a long flow channel carbon black having an oil absorption of at least 85 pounds of oil per 100 pounds of black, and a fine thermal carbon black.

11. In the method of bonding refractory particles selected from the group consisting of dead-burned dolomite, dead-burned magnesia, and mixtures thereof by blending such particles with sufficient coal tar pitch to bind said particles together, shaping such blend under pressure, and then heating the resulting shape to a temperature sufficient to decompose pyrolytically the pitch and form a carbon bond, the improvement which consists of adding to the blend prior to shaping approximately 0.5 to 10 percent by weight, based on the weight of the total admixture, of powdered carbon black containing particles having a diameter within the range of from about 20 millimicrons to about 500 millimicrons[.] *to increase the density and crushing strength of such carbon bonded shape, at least one third of such carbon black being thermal carbon black having an average particle diameter within the range of about 180 to about 470 millimicrons.*

✓ [12. In the method of bonding refractory particles

selected from the group consisting of dead-burned dolomite, dead-burned magnesia, and mixtures thereof by blending such particles with sufficient coal tar pitch to bind said particles together, shaping such blend and then heating the resulting shape to a temperature sufficient to decompose pyrolytically the pitch and form a carbon bond, the improvement which consists of adding to the blend prior to heating from about 1 percent to about 3 percent by weight thereof of finely divided carbon black having properties within the following ranges:

Average particle diameter ... 120 to 500 millimicrons.
Surface area ... 6 to 13 square meters per gram.
Volatile content ... Less than 1% by weight.
Fixed carbon ... 95 to 99.5% by weight.]

✓ [13. A refractory article of manufacture consisting essentially of basic refractory particles, sufficient carbonaceous material capable of pyrolytic decomposition selected from the group consisting of pitch, coal tar and bituminous asphalts to bind said particles together and approximately 0.5 to 10 percent by weight, based on the weight of the total admixture, of finely divided carbon black of non-crystalline structure.]

14. A refractory article of manufacture consisting essentially of basic refractory particles, carbon black and a pyrolytically decomposed carbonaceous material selected from the group consisting of pitch, coal tar and bituminous asphalts, approximately 0.5 to 10 percent by weight, based on the weight of the total admixture, of said carbon black being present prior to such pyrolytic decomposition[.], *said refractory article having increased density and crushing strength and said carbon black having an average particle size of from about 20 to 500 millimicrons and a surface area of about 5 to about 375 square meters per gram, at least one third of such carbon black being thermal black having an average particle diameter of about 180–470 millimicrons and a surface area of about 6–13 square meters per gram.*

15. The method of claim 11 in which such powdered carbon black consists essentially of a blend of a high oil absorbing carbon black and a thermal carbon black, said carbon black being present within the weight ratio of 2:1 to 1:2 respectively.

16. A pitch-bonded refractory having high strength and increased density comprising

basic refractory particles,

sufficient carbonaceous material selected from the group consisting of pitch, coal tar and bituminous asphalts, capable of pyrolytic decomposition, to bind said particles together, and

approximately 0.5 to 10% by weight, based on the weight of the total admixture, of finely divided carbon black of noncrystalline structure, said carbon black having an average particle size of from about 20 to 500 millimicrons and a surface area from about 5 to about 375 square meters per gram, at least on third of the carbon black being thermal carbon black having an average particle diameter of from about 180 to about 470 millimicrons and a surfece area of about 6–13 square meters per gram.

17. The refractory of claim 16 in which said finely divided carbon black consists essentially of a blend of a high oil absorbing carbon black and said thermal carbon black.

18. The refractory of claim 17 wherein the ratio of high oil absorbing carbon black to thermal carbon black is in the range of about 2:1 to about 1:2 respectively.

19. The refractory of claim 17 wherein said oil absorbing carbon black has an oil absorption of at least about 85 pounds of oil per 100 pounds of carbon black.

20. The refractory of claim 19 including about 4 to about 10% of carbonaceous material.

21. The refractory of claim 16 wherein the carbon black addition is substantially all thermal black.

22. The method of claim 5 wherein such carbon black comprises about 66 percent by weight to about 33 percent by weight thermal black.

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